

Fishery Data Series No. 18-33

Anchor River Chinook Salmon Escapement, 2013

by

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and

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Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General		Mathematics, statistics		
centimeter	cm	Alaska Administrative Code	AAC	all standard mathematical signs, symbols and abbreviations		
deciliter	dL	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	alternate hypothesis	H _A	
gram	g	all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.	base of natural logarithm	<i>e</i>	
hectare	ha			catch per unit effort	CPUE	
kilogram	kg			coefficient of variation	CV	
kilometer	km	at compass directions:	@	common test statistics	(F, t, χ^2 , etc.)	
liter	L			confidence interval	CI	
meter	m			correlation coefficient (multiple)	R	
milliliter	mL	east	E	correlation coefficient (simple)	r	
millimeter	mm	north	N	covariance	cov	
Weights and measures (English)		south	S	degree (angular)	°	
	cubic feet per second	ft³/s	west	degrees of freedom	df	
	foot	ft	copyright	expected value	<i>E</i>	
	gallon	gal	corporate suffixes:	greater than	>	
	inch	in	Company	greater than or equal to	≥	
	mile	mi	Corporation	harvest per unit effort	HPUE	
	nautical mile	nmi	Incorporated	less than	<	
	ounce	oz	Limited	less than or equal to	≤	
	pound	lb	District of Columbia	logarithm (natural)	ln	
	quart	qt	et alii (and others)	et al.	logarithm (base 10)	log
yard	yd	et cetera (and so forth)	etc.	logarithm (specify base)	log ₂ , etc.	
Time and temperature		exempli gratia		minute (angular)	'	
	day	d	(for example)	e.g.	not significant	NS
	degrees Celsius	°C	Federal Information Code	FIC	null hypothesis	H ₀
	degrees Fahrenheit	°F	id est (that is)	i.e.	percent	%
	degrees kelvin	K	latitude or longitude	lat or long	probability	P
	hour	h	monetary symbols		probability of a type I error	
	minute	min	(U.S.)	\$, ¢	(rejection of the null hypothesis when true)	α
	second	s	months (tables and figures): first three letters	Jan,...,Dec	probability of a type II error	
	Physics and chemistry		registered trademark	®	(acceptance of the null hypothesis when false)	β
		all atomic symbols		trademark	™	second (angular)
alternating current		AC	United States		standard deviation	SD
ampere		A	(adjective)	U.S.	standard error	SE
calorie		cal	United States of America (noun)	USA	variance	
direct current		DC	U.S.C.	United States Code	population sample	Var var
hertz		Hz	U.S. state	use two-letter abbreviations		
horsepower		hp		(e.g., AK, WA)		
hydrogen ion activity (negative log of)		pH				
parts per million		ppm				
parts per thousand	ppt, ‰					
volts	V					
watts	W					

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ABSTRACT

The 2013 Anchor River Chinook salmon (*Oncorhynchus tshawytscha*) escapement (4,401 fish, SE 117) fell within the sustainable escapement goal (SEG) range of 3,800–10,000 fish. High river flows changed the channel morphology at the confluence of the north and south forks, which rendered the 2003–2012 mainstem dual-frequency identification sonar (DIDSON) site unsuitable for monitoring escapement. Thus, for the 2013 season, the DIDSON was relocated about 0.3 river kilometers (RKM) downstream and was operated throughout the high-water period. Once flows subsided, 2 alternative escapement monitoring sites were identified upstream: 1 on the south fork and 1 on the north fork. The north fork site was located approximately 1.5 RKM upstream from the confluence and the south fork site was located approximately 0.2 RKM upstream of the confluence. Weirs and underwater video systems were used at both sites to monitor escapement. The midpoint of the Chinook salmon run was 19 June. The daily Chinook salmon escapement counts were positively correlated with daily average river stage, but not with daily average river temperature. The dominant age class was ocean-age-3 (43.5%, SE 4.1%). Overall mean length of males (604 mm, SE 15) was smaller than that of females (734 mm, SE 25). The inriver sport fishery was restricted by a series of emergency orders that probably resulted in a near record-low harvest of 97 fish.

Key words: Anchor River, Chinook salmon, *Oncorhynchus tshawytscha*, sustainable escapement goal, stock status, weir, sonar, DIDSON

INTRODUCTION

The Anchor River is located on the southern portion of the Kenai Peninsula (Figure 1) and supports the largest Chinook salmon (*Oncorhynchus tshawytscha*) run in the Lower Cook Inlet Management Area (LCIMA) with estimated total runs ranging from about 4,100 to 13,600 fish (2003–2012; Kerkvliet et al. 2016). There are 3 streams open to sport fishing for Chinook salmon in the LCIMA: Anchor River, Deep Creek, and Ninilchik River. In Alaska, most juvenile Chinook salmon remain in fresh water until the following spring when they migrate to the ocean as smolt in their second year. Based on scale age data, Anchor River Chinook salmon spend 1 to 4 years feeding in salt water before they return to spawn (Kerkvliet and Booz 2012). Run timing of adult Chinook salmon into these streams is approximately early May through late July with a peak in early to mid-June (Kerkvliet et al. 2008; Kerkvliet and Burwen 2010; Kerkvliet and Booz 2012; Kerkvliet et al. 2012).

The Anchor River watershed is approximately 587 km² with about 266 river kilometers (RKM) of anadromous streams (Table 1). The Anchor River has 2 major forks (south and north forks) and their confluence is located approximately 2.8 RKM upstream from the mouth. The south fork watershed is approximately twice the size of the north fork watershed. Because of the Anchor River's small size, geomorphology, and vegetation, water flows can rise quickly and substantially following heavy rains.

Anchor River Chinook salmon are primarily harvested during an inriver sport fishery. The inriver sport fishery is restricted by regulation through small daily and seasonal bag limits, and limits on days and areas open to sport fishing. The annual Chinook salmon catch and harvest in the Anchor River sport fishery is estimated by the Statewide Harvest Survey (SWHS; Table 2). From 2003 to 2012, the average SWHS Chinook salmon inriver harvest was 1,068 (SE 187). An unknown number of Anchor River Chinook salmon are also harvested in a mixed-stock sport troll fishery within Cook Inlet near the river mouth.

Before 2003, there were problems enumerating the Anchor River Chinook salmon escapement over the entire run. Traditional sonar methods (e.g., split-beam sonar), commonly used in large Alaskan rivers at the time (e.g., the Kenai River), were not suited for smaller streams like the Anchor River because of periodic low water conditions that are too shallow to insonify. Also,

traditional weir methods (fixed picket or resistance board weirs), commonly used in small streams, could not be installed in the Anchor River in May and early June because the river is typically too high and swift at that season for installation. Therefore, an annual aerial survey was conducted during peak spawning to index and evaluate Chinook salmon escapement (Appendix A1). However, because of the inherent biases associated with the index counts (e.g., differences in survey conditions and surveyor biases) year-to-year comparisons of Chinook salmon escapement indices have been difficult and inconclusive.

In 2003, dual-frequency identification sonar (DIDSON) manufactured by Sound Metrics Corporation (SMC)¹ was used to monitor Chinook salmon escapement in the Anchor River (Kerkvliet et al. 2008). The DIDSON was deployed on the mainstem of the Anchor River just below the north and south forks confluence and just upstream of the fishery at a site where the river profile was relatively level (Figure 2).

The 2003 Anchor River Chinook salmon escapement (9,238 fish) was higher than expected even though the DIDSON began operating in late May, after the beginning of the run, and stopped operating in early July, before the run had ended (Table 3). It was estimated that the measured escapement in 2003 represented about 70% of the true escapement based on the average proportion of the runs in 2004 and 2005 (2 years with similar water temperatures and flow rate patterns) that escaped over the same time period. From 2004 to 2008 and 2010 to 2011, the Chinook salmon escapement was estimated using the DIDSON during the high discharge rates and water levels in early spring through early to mid-June and was estimated using a resistance board weir thereafter. In 2009, the DIDSON was not required because low water levels allowed for the immediate installation of the resistance board weir, which provided the first complete Anchor River Chinook salmon escapement census. In 2010, an underwater video system was incorporated into the weir and used to monitor escapement near the end of the run in early August (Kerkvliet and Booz 2018a). Beginning in 2011, an underwater video system was used throughout the weir operation (Kerkvliet and Booz 2018b, 2018c).

Anchor River Chinook salmon escapement counts based on DIDSON have a negative bias because all sonar images of fish swimming upstream and downstream are assumed to be Chinook salmon even though an unknown portion of the downstream sonar images include postspawning steelhead (*Oncorhynchus mykiss*) kelts emigrating out of the river. In 2009, with the early weir installation, both emigrating kelts and immigrating Chinook salmon were monitored at the sonar-weir site (Kerkvliet and Booz 2012). The midpoint of the 2009 kelt emigration (7 June) was earlier than the midpoint of the Chinook salmon immigration (23 June). Given a typical weir installation date of early to mid-June, and assuming the timing of the 2009 kelt emigration was typical, then a large portion of the kelt emigration may occur during the DIDSON operation. Based on the census of immigrating Chinook salmon and emigrating kelts in 2009, the negative bias had the DIDSON been used would have been at most 17%. Note that this percentage was based on the lowest escapement of Chinook salmon between 2003 and 2012. A similar emigration of steelhead during the highest measured Chinook salmon run would translate to a negative bias of about 5%.

Since 2003, the annual Chinook salmon escapement in the Anchor River has ranged from 3,455 (SE 0) in 2009 to 12,016 (SE 283) in 2004 (Table 4). Inriver exploitation rates (percentage of the total run that is harvested) have ranged from less than 9.9% in 2003 to 21.7% in 2008.

¹ Product names and manufacturers used in this publication are included for completeness but do not constitute product endorsement.

The Anchor River Chinook salmon escapement goal has been refined as annual escapement data have become available (Appendix A2). In 2010, ADF&G modified the goal to a sustainable escapement goal (SEG²) of 3,800–10,000 Chinook salmon. The SEG was set by using the full probability spawner-recruit model described in Szarzi et al. (2007) and updated with the most recent escapement and harvest through 2009 (Otis et al. 2010). The lower end of the SEG is the point estimate for maximum sustained yield and the upper bound is estimated carrying capacity. The range minimizes the risk of overfishing and allows for liberalization of the harvest when escapements are large.

Anchor River sport fishing regulations have undergone a series of changes since the early 2000s as escapement assessment improved (Appendix A3; Kerkvliet et al. 2013). Beginning in 2009, the inriver and nearby marine fisheries were restricted by emergency order (EO) in response to low Chinook salmon escapement. Despite the restrictions, the lower bound SEG of 5,000 was not achieved. In 2010, the Alaska Board of Fisheries (BOF) reduced the Anchor River annual limit to 2 Chinook salmon in combination with Deep Creek and also extended the conservation zone surrounding the Anchor River mouth from 1 mile north and south to 2 miles north and south from 1 April to 30 June. The other restrictions remained unchanged: scheduled Chinook salmon sport fishery openings began on the 3-day weekend before Memorial Day weekend followed by the 4 consecutive 3-day weekends and the 5 Wednesdays following each weekend.

This report is part of a continuing series that evaluates the Anchor River Chinook salmon stock. Chinook salmon escapement estimates from this report will be used in future escapement goal analyses and also to manage the fishery according to the *Sustainable Fisheries and Escapement Goal Policy* (Alaska Administrative Code 5 AAC 39.223).

OBJECTIVES

Primary Objectives

- 1) Estimate the Chinook salmon escapement that passes upstream of the Anchor River mouth at RKM 4.0 on the south fork and at RKM 5.3 on the north fork from approximately 13 May through 4 August.
- 2) Estimate the age and sex composition of the Chinook salmon escapement.

Secondary Objectives

- 1) Estimate length, age, and sex composition of the Chinook salmon escapement.
- 2) Examine between-reader and within-reader variation of DIDSON counts.
- 3) Determine seasonal and diel³ run timing of Chinook salmon.
- 4) Compare daily escapement to daily river stage and temperature averages.
- 5) Examine all Chinook salmon sampled for age, sex, and length (ASL) for an adipose fin.

² SEG is a level of escapement indicated by an index or estimate that is known to provide sustained yield for over a 5–10 year period (Alaska Administrative Code 5 AAC 39.223).

³ “Diel” is defined as “of or pertaining to a 24-h period.”

METHODS

OPERATION DATES AND EQUIPMENT

In 2013, high spring flows in mid-May rechanneled the river at the 2003–2012 monitoring site at RKM 2.8, located on the mainstem Anchor River adjacent to the confluence of the north and south forks (Figures 2 and 3). The river channel widened, and an island was created that extended through the monitoring site rendering it unsuitable for monitoring escapement; these changes necessitated identifying new monitoring sites inseason. During the early season high flows, the DIDSON was moved approximately 0.3 RKM downstream of the mainstem site to a site locally known as “Bridge Hole.” Although this temporary monitoring location was within the Chinook salmon sport fishery area, it still allowed for the entire escapement to be counted in 2013 because sport fishing was closed at Bridge Hole by a preseason EO (Appendix A3). In order to continue monitoring the entire escapement above the sport fishery in 2013 and in future years, new weir sites were identified upstream on the north and south forks. The nearest suitable site on the north fork was about 5.4 RKM from the mouth (lat 59°46.323'N, long 151°49.935'W), which about 1.5 RKM upstream of the previous mainstem sonar site. The nearest suitable site on the south fork was about 4.1 RKM from the mouth (lat 59°46.719'N, long 151°49.107'W), which was located about 0.2 RKM upstream of the previous mainstem sonar site.

Escapement was monitored via DIDSON at the Bridge Hole from 19 May at 1900 hours through 19 June at 1200 hours (Figure 4, Table 5). Escapement was monitored at the weir sites from 19 June at 1300 hours through 3 August at 2359 hours using a fixed picket weir at the north fork site (Figure 5) and a resistance board weir on the south fork site (Figure 6). Each weir was fitted with an underwater video system in the passage chute to monitor escapement with the same methods used at the mainstem site (Kerkvliet and Booz 2018c).

Beach seines were used to capture Chinook salmon for age, sex, and length (ASL) estimation. Four river reaches were seined (Table 6). The south fork, with 2 river reaches, was seined 4 times from 6 June to 17 July, and the north fork, with just 1 river reach, was seined 4 times from 22 May and 9 July (Table 7). During weir operations on the north and south forks, ASL samples were collected from the weir live box from 13 June to 9 July; however, due to low fish passage and failure to reach sample size goals (Kerkvliet and Booz 2013), samples were also collected downstream of the weirs on 11 July using a beach seine.

To reduce the number of Chinook salmon double counted during the transition from DIDSON to weir monitoring, beach seines were used to capture Chinook salmon in the river sections between the north fork and south fork weir sites and the Bridge Hole DIDSON site on 19 June at 1300 hours. All captured Chinook salmon were given an upper caudal fin clip that could be identified in video monitoring. Seine-captured fish were counted daily but were not included in the daily and cumulative escapement counts. The substrate between the north fork site and the mainstem site is composed primarily of large cobble and boulders and not considered good spawning habitat for Chinook salmon. Prior to removing the weir at the north fork site, a helicopter survey was conducted on 3 August to account for the number of Chinook salmon between the old mainstem site and the north fork site.

DIDSON and Partial Picket Weirs

In 2013, an ultra-high-resolution large lens (hereafter called “large lens”) was used in the DIDSON. The large lens almost doubles the resolution of the standard lens and has a smaller

vertical beam pattern; the resolution is also better at the longer ranges (>15 m) needed at the Anchor River than the standard lens. However, the highest image resolution for the large lens is still achieved when the DIDSON is operated at shorter ranges using the higher of 2 available frequencies (Burwen et al. 2007, 2010; Kerkvliet and Booz 2018a).

Because the width of the Anchor River at the Bridge Hole during high water conditions (approximately 31 m) was greater than the effective range of the DIDSON (approximately 20 m), a partial weir was installed on the left bank to narrow the insonified corridor to 20 m or less. The weir was constructed of steel A-frame structures joined together with upright PVC pickets threaded through aluminum frames (Figure 4). Additional frames and pickets could be added or removed as necessary due to changing water levels. The weirs were extended to narrow the insonified corridor to about 10 m. All bottom irregularities at the base of the partial weirs were sealed using sandbags that prevented fish from migrating past the DIDSON undetected.

The DIDSON was first enclosed in an SMC silt protection box, and then mounted on a “goalpost” type mount. Aiming was done manually via hand-crank built into the mount. The communication cables from the DIDSON led to electronics inside a travel trailer. DIDSON data were collected using DIDSON software (version 5.25.28), stored on a Dell laptop computer, transferred via an external hard drive, and processed on a Dell desktop computer using Echotastic software (version 2.5). Separate computers were used for data collection and processing to avoid data corruption or interruption of recording. Files were saved every 20 minutes and designated as first, second, and third 20-minute count files. All electronics were powered by a 2000 W generator with an inline battery backup system composed of six 100 Ah 12 V batteries run in parallel to a 600 W inverter.

The DIDSON was positioned approximately 0.5 m upstream and no less than 3 m towards the bank from the terminal end of the left bank weir (the left bank is defined as the left side of the river facing downstream). The DIDSON lens was aimed slightly downward across the insonified corridor and was positioned at least 10 cm off the river bottom. The aim of the DIDSON resulted in an insonified cone to the left bank that ensured full coverage of the migration corridor.

Weirs

South Fork

Once materials were staged, the resistance board weir (approximately 31 m long) was installed. Picket spacing for the resistance board weir and live boxes were approximately 2.8 cm (1.5 in) to block the passage of all but the smallest ocean-age-1 Chinook salmon (Figure 6). A live box was attached to the upstream edge of the weir, and an underwater video system was then attached to the upstream edge of the live box, allowing fish to pass upstream 24 hours per day, 7 days per week. The live box–underwater video system was installed approximately 3 m from the right bank near the thalweg. All bottom irregularities along the base of the resistance board weir were sealed using sandbags and a fencing skirt. The weir was visually inspected for holes daily to ensure no fish could migrate past undetected.

During June, a “steelhead chute” was formed near the thalweg by weighting the downstream end of a resistance board weir panel with a sandbag. The weight of the sandbag allowed a shallow stream of water that fish could use to swim downstream over the weir. The placement of the sandbag was used to adjust the water depth flowing over the weir panel so that it was deep enough

to allow kelts to swim downstream, but shallow enough to prevent upstream migration. No counts of steelhead trout were made in 2013.

The underwater video system consisted of a sealed aluminum box containing an underwater video camera and 2 underwater 20 W halogen lights attached to a fish passage chute. The system was installed on the upstream end of the live box. As fish swam through the live box, they entered the fish passage chute and passed the video camera. The camera box was attached with the glass front towards the side of the fish passage chute.

The box was constructed of 3.2 mm aluminum sheeting and had a sealed 9.5 mm thick safety glass front (referred to as “camera box” below). The box also had a sealed hatch on the top to allow access inside the box and a 1 m tube for running cables through the box. The box was filled with distilled water to provide a clear water lens in front of the camera to increase video quality, provide protection for the camera from silt, and provide weight to sink it. The camera was mounted on a rail in the bottom of the box with an adjustable mount and aimed through the safety glass towards the fish passage chute. The lights were mounted on rails and aimed in a way to illuminate the entire focal range of the camera throughout the day. The passage chute was roughly 1 m long by 0.4 m wide and constructed of angle and sheeting aluminum. It had a removable background and lid. The background was set to constrict the width of the fish passage chute to 15 cm but could be adjusted laterally to widen or narrow fish passage. The lid was used to prevent natural light within the fish passage chute. Both the background and lid were removed as needed to clean the glass.

The video system recorded fish passage 24 hours per day using motion detection software through a digital video recorder (DVR) capture card installed into a Dell desktop computer. All video files were recorded at 30 frames per second and written to a 3-terabyte external hard drive. The computer was stored inside a metal toolbox and powered with the same generator and battery system as the DIDSON. Video files of motion detected fish images were reviewed with Watchnet software provided by the DVR capture card manufacture.

North Fork

A road easement adjacent the new north fork site was used to stage weir materials at the site prior to installation of a (~13 m) fixed picket weir (Figure 5). Picket spacing of the weir and live boxes were approximately 2.8 cm (1.5 in) to block the passage of all but the smallest ocean-age-1 Chinook salmon. All bottom irregularities along the base of the weir were sealed using sandbags. The weir was visually inspected for holes daily to ensure no fish could migrate past undetected.

A live box was attached to the upstream edge of the weir and an underwater video system was then attached to the upstream edge of the live box. The live box underwater video system was installed about 1.5 m from the right bank near the thalweg. The underwater video system, described above for the south fork, was also installed on the upstream end of the live box and operated as described above.

Beach Seining to Mitigate Double Counting

Historically, the transition from using DIDSON to using weirs for monitoring escapement was readily accomplished because the weir was installed approximately 5 m downstream of the DIDSON and the weir was made fish tight before it began monitoring escapement. In 2013, double counting was a concern because of the distances from the Bridge Hole DIDSON site to the north fork and south fork weir sites (upstream approximately 1.5 RKM and 0.5 RKM, respectively). On 19 June at 1300 hours, escapement monitoring was transitioned from DIDSON to weir counts

(Table 5). To account for Chinook salmon that had already been counted using DIDSON but had not yet reached the weir sites at the time of transition, the following measures were taken on 19 June: 1) the river section between the Bridge Hole and weir sites were beach seined before 1300 hours and the caudal fin was clipped on all captured Chinook salmon to signify they had been counted by the DIDSON, 2) the transition from DIDSON to weirs was synchronized to occur simultaneously at both weir sites at 1300 hours, and 3) all caudal-clipped Chinook salmon observed at the weir sites through 12 July⁴ following the transition were presumed to have been counted using the DIDSON and therefore were not included in the daily count. It is noted that this adjustment did not mitigate the double-counting problem completely because it is not possible to capture all fish by beach seining.

ESCAPEMENT MONITORING

DIDSON

In 2013, images of fish moving either upstream or downstream were counted for a 20-minute period for each hour the DIDSON was operated. The counts from the 20-minute DIDSON file were then expanded to the hour to represent fish passage for a given hour. For quality control and to evaluate reader variability, three 20-minute files were selected each day and recounted by both the individual who had done the initial count and by a different individual.

DIDSON counts were treated as follows:

- 1) Images of fish moving upstream were assumed to be Chinook salmon because of migratory timing even though a very small (unknown) percentage may have been steelhead.
- 2) Images of fish moving downstream were assumed to be Chinook salmon. This assumption is flawed to some degree; it is known that a portion of the downstream counts include steelhead emigrating from the river. No adjustments were made to the downstream counts because it is impossible to differentiate downstream moving Chinook salmon from steelhead. This assumption can lead to an underestimation of the Chinook salmon escapement.

Weirs

Escapement counts from each fork were tallied by hour and species as video files were reviewed. For each fork, hourly counts were summed to a daily count. The total daily counts were a sum of the total counts from each fork.

Run Timing

Run timing was assessed at each monitoring site using cumulative daily and hourly counts. The association of daily escapement counts with daily water temperature and river stage was assessed using information contained in the following data sets:

⁴ Chinook salmon caught on 19 June were mismarked with an upper caudal fin clip instead of a lower caudal fin clip; therefore, they could not be distinguished from Chinook salmon sampled for ASL data. There was a 6-day break between 13 July and 18 July when no marked Chinook salmon were observed through the weirs. It was assumed that by 12 July, all the Chinook salmon marked on 19 June had either been counted through the weir or remained downstream of the weir and that all marked Chinook salmon counted thereafter were new fish and should be included in the escapement count; however, these fish may have eventually migrated upstream through the weirs and been counted erroneously.

- 1) Water temperature: Recorded by datalogger every 15 minutes by Cook Inletkeeper (CIK), a citizen-based nonprofit group. The logger was installed approximately 0.1 RKM downstream of the sonar-weir site (Mauger 2013). Daily temperatures (average, minimum, and maximum) were averaged from logger readings collected every 15 minutes.
- 2) River stage: Recorded hourly from the gauge station (USGS 15239900) by the U.S. Geological Survey (USGS). The station is located on the south fork at approximately 11.4 RKM from the mouth of the Anchor River at a New Sterling Highway bridge.

BIOLOGICAL DATA

Three methods were used to assess Chinook salmon age, sex, and length (ASL) composition: beach seine capture, live box capture, and video imagery. Chinook salmon were either captured by drifting a beach seine (30.5 m long by 2 m deep with 5.1 cm stretched mesh size) through deep pools (Kerkvliet et al. 2008) or in the live boxes at the north and south fork weirs. Capture methods and beach seine sampling locations were adapted inseason to meet sample size goals. Throughout the underwater video weir operation, images of external characteristics of Chinook salmon were used to determine sex.

To assess age, 3 scales were collected from each Chinook salmon from the preferred area on the fish's left side and mounted to a gum card (Welander 1940). Sex was visually determined through external characteristics and the mid eye to tail fork (METF) length was measured to the nearest 5 mm.

The upper lobe of the caudal fin was also clipped on all Chinook salmon before release to prevent double sampling. Scales were aged using a microfiche reader and with methods described by Welander (1940). Scales were aged without reference to size, sex, or other data. Scale samples were aged twice to estimate within-reader variability. Since 2007, the same individual has aged Anchor River Chinook salmon scales; the individual is tested annually with known aged scales (from recovered coded-wire-tagged fish). All scale samples that had conflicting ages for the 2 estimates were re-aged to produce a resolved age which was then used for composition and abundance estimates.

ASL samples were collected from Chinook salmon captured in beach seines from 22 May through 17 July (Table 7). Early in the season due to high river levels, only the north fork could be safely seined, but as water levels lowered, the south fork was also sampled. The reaches traditionally seined since 2003 were used again in 2013 (Table 6, Figure 7). The south fork was sampled only once during the DIDSON period and catches were low in the pools and channel compared to catch rates from prior years.

On 20 June, the day after the escapement monitoring transitioned from DIDSON to weir counts, the south fork was seined again to collect ASL samples to improve sample size. Thereafter ASL sampling was attempted from the weir live boxes, but an insufficient number of Chinook salmon were captured in the weir live boxes to reach the desired sampling rate. To increase the ASL sample size, the north and south fork reaches were seined on 8 July and 9 July, respectively. On 11 July, the mainstem reach from Bridge Hole to RKM 1.7 was seined to collect additional ASL samples. Due to the low sampling rate from the weir live boxes, live box sampling was ceased on 15 July. On 17 July, the upper reach of the south fork beginning at approximately RKM 18.4, was seined to increase the sample size of Chinook salmon heading up the south fork.

ADIPOSE FIN INSPECTION

Each Chinook salmon captured with a beach seine or sampled from the weir live box was inspected for the presence of an adipose fin. If a fish was found missing an adipose fin, indicating a hatchery-reared fish, it was sacrificed, and the head was sent to the Alaska Department of Fish and Game (ADF&G) Mark, Tag, and Age Lab to identify the release site using coded wire tag (CWT) information recovered from the head. Recovered CWTs were used to validate age data. No video recordings were used to inspect Chinook salmon for adipose fins.

DATA ANALYSIS

Escapement

Net DIDSON counts from 20-minute files within the j th hour ($j = 1, \dots, 24$) of the k th day of the season were calculated as follows:

$$n_{jk} = u_{jk} - d_{jk}, \quad (1)$$

where

u_{jk} = upstream counts in hour j of day k , and

d_{jk} = downstream counts in hour j of day k .

Net upstream counts for each hour were estimated as follows:

$$\hat{c}_{jk} = \frac{60}{t_{jk}} n_{jk}, \quad (2)$$

where t_{jk} is the number of minutes sampled during the j th hour on day k (target is 20 minutes).

In 2013, there were more numerous instances of missing hourly counts than in previous years. Sixty-one hours of counts were missing for the DIDSON, whereas 5 and 11 hours were missing for the north and south forks, respectively. The missing counts were interpolated using historical hour-specific diel timing curves calculated using Anchor River passage data from 2003 through 2012. Interpolations were calculated using the average diel timing curve to expand available counts from the day counts that were missing and from one day previous and after the day in which counts were missing. No account was taken to incorporate additional variation induced by the interpolation; only about 1% of the final escapement estimate was interpolated.

Hourly count estimates (\hat{c}_{jk}) were summed to provide daily estimates of escapement (C_k) and an estimate of the total escapement passage (C_D) during DIDSON system operation:

$$\hat{C}_k = \sum_{j=1}^{24} \hat{c}_{jk} \quad (4)$$

and

$$\hat{C}_D = \sum_{k=1}^K \hat{C}_k, \quad (5)$$

where K is the total number of days of operation of the DIDSON system in the year in question.

The variance of \hat{C}_D was estimated as follows:

$$\text{var}(\hat{C}_D) = \sum_{k=1}^K \text{var}(\hat{C}_k) = \sum_{k=1}^K \sum_{j=1}^{24} \text{var}(\hat{c}_{jk}), \quad (6)$$

where

$$\text{var}(\hat{c}_{jk}) = \left[\frac{60}{t_{jk}} \right]^2 \text{var}(n_{jk}) = \left[\frac{60}{t_{jk}} \right]^2 s^2 \left[1 - \frac{t_{jk}}{60} \right], \quad (7)$$

and where s^2 is calculated as the successive difference estimate of variance for a systematic sample (Wolter 1985):

$$s^2 = \frac{\sum_{h=2}^H (n_h - n_{h-1})^2}{2(H-1)}, \quad (8)$$

where H is the total number of samples, n_h is the count of the h th sample, n_1 corresponds to the first count of the season ($j = 1, k = 1$), and n_H corresponds to the last count of the season ($j = 24$ and $k = K$).

The estimated total Chinook salmon passage over the entire season was calculated as follows:

$$\hat{C}_T = \hat{C}_D + C_W, \quad (9)$$

where C_W is the count of Chinook salmon through the north fork and south fork weirs; the variance of \hat{C}_T was estimated as follows:

$$\text{var}(\hat{C}_T) = \text{var}(\hat{C}_D). \quad (10)$$

Count Diagnostics

Re-counted DIDSON files provided a measure of reproducibility for escapement counts and a quality control measure. Between-reader and within-reader variability was assessed for the 2 crewmembers responsible for counting DIDSON files. Between-reader variability was assessed by comparing counts from the primary (initial counter) and secondary (re-counter) reader for three 20-minute files each day. Within-reader variability for the primary reader was assessed by comparing counts from three 20-minute DIDSON files each day (i.e., each file was read twice by a reader). Re-counted files were chosen to represent challenging counting conditions (e.g., high upstream and downstream counts and milling activity); the analysis therefore revealed worst-case scenarios of between- and within-reader variability. The following statistics were calculated for the between- and within-reader analyses:

- 1) Kendall's tau was calculated for each pair of counts as well as for all first and second readings. Kendall's tau ranges from -1 to 1 , representing perfect negative and positive correlation, respectively.
- 2) Intraclass correlation coefficient r was calculated for each pair of readers counting the same files (Shrout and Fleiss 1979). This statistic is a function of the correlation and agreement between counts. It ranges from 0 to 1 ; it is high when there is little variation between the scores given to each count. The function `icc()` in the R package `{irr}` was used with model argument set to "twoway" and type argument to "agreement."
- 3) A Tukey difference plot was made for the pair of readers counting the same files (Bland and Altman 1986). These plots are of differences between counts against the average of the scores of the readers.

Run Timing

Chinook salmon run timing at the sonar and weir sites were described using cumulative daily counts and associated percentages. The quarter point and midpoint of the Chinook salmon run was defined as the date nearest the 25% and 50% cumulative count, respectively. Diel run timing was evaluated using 24-hour DIDSON counts and video weir counts. DIDSON and video weir counts were summed over the season by hour and plotted against hour of day. The correlation of daily counts within the middle 80% of the run with daily river stage averages and river temperatures was also examined with Pearson's correlation coefficient (r). The hypothesis that there was no correlation ($r = 0$) was tested.

Age and Sex Composition and Length-at-Age

Age and sex compositions were estimated from all pooled samples obtained throughout the season. Pooled beach seine samples derived from equal effort from the north and south forks is thought to be the best way to obtain a representative sample of the migration occurring during sonar operation (Kerkvliet et al. 2008).

The estimated proportion of Chinook salmon of age or sex class k (or a combination thereof), in the escapement during a given period x (where x is either W [Weir] or D [DIDSON]) was calculated as follows:

$$\hat{p}_{xk} = \frac{n_{xk}}{n_x}, \quad (11)$$

where

n_{xk} = the total number of salmon of age or sex class k in n_x , and

n_x = the number of salmon sampled during period x .

The estimated proportion of Chinook salmon of age or sex class k (or a combination thereof) in the entire escapement to the Anchor River was calculated as follows:

$$\hat{p}_k = \phi_D \hat{p}_{Dk} + (1 - \phi_D) \hat{p}_{Wk}, \quad (12)$$

where ϕ_D is the proportion of the entire escapement that migrated during the DIDSON operation (treated as a constant), and the estimated variance of proportion \hat{p}_k was calculated as follows:

$$\text{var}(\hat{p}_k) = \phi_D^2 \left[\left(\frac{\hat{C}_D - n_D}{\hat{C}_D} \right) \frac{\hat{p}_{Dk}(1 - \hat{p}_{Dk})}{n_D - 1} \right] + (1 - \phi_D)^2 \left(\frac{C_W - n_W}{C_W} \right) \frac{\hat{p}_{Wk}(1 - \hat{p}_{Wk})}{n_W - 1}. \quad (13)$$

\hat{C}_D from Equation 5 is measured with high precision and is included in the finite population correction factor in Equation 13 as a constant.

The estimated total number of Chinook salmon of age or sex class k was calculated as

$$\hat{N}_k = \hat{C}_T \hat{p}_k, \quad (14)$$

where C_T is calculated in Equation 9.

The estimated variance of \hat{N}_k was calculated as (Goodman 1960):

$$\text{var}(\hat{N}_k) = \hat{C}_T^2 \text{var}(\hat{p}_k) + \hat{p}_k^2 \text{var}(\hat{C}_T) - \text{var}(\hat{p}_k) \text{var}(\hat{C}_T). \quad (15)$$

Mean lengths-at-age and their variances were estimated using standard summary statistics.

The within-reader variability of Chinook salmon scale age estimates was calculated using a coefficient of variation (CV) expressed as the ratio of the standard deviation over the mean age (Campana 2001):

$$CV_j = 100\% \times \frac{\sqrt{\sum_{i=1}^R \frac{(X_{ij} - X_j)^2}{R - 1}}}{X_j}, \quad (16)$$

where

X_{ij} = the i th age estimate of the j th fish,

X_j = the mean age estimate of the j th fish, and

R = the number of times each fish is aged.

RESULTS

ESCAPEMENT

The estimated 2013 Anchor River Chinook salmon escapement of 4,401 (SE 117) fish was within the SEG range of 3,800–10,000 fish (Table 4, Appendix B1). The escapement was based on expanded sonar counts (2,238 fish, SE 117; Appendix C1), and the census of 2,163 Chinook salmon counted through the south fork (1,577 fish) and north fork (586 fish) weirs combined (Appendices B2 and B3). During the DIDSON operation, counts were interpolated for 61 hours due to electronic malfunctions (Appendix B4). Most of the May counts were set to 0 to reduce

negative bias due to negative fish counts. During the weir operations, 11 hours of Chinook salmon counts were interpolated for the south fork and 6 hours were interpolated for the north fork due to video malfunctions. Excluding the days when counts were set to 0, the ratio of upstream to downstream moving fish averaged 1.6:1.

On 19 June, when escapement monitoring transitioned from DIDSON to weir counts, the expanded DIDSON estimate from 0000 to 1200 hours was 336 fish (Appendix C1). During beach seining on 19 June between Bridge Hole and the north and south fork weirs, 116 Chinook salmon were captured and received caudal clips. Most of the fish ($n = 94$) were captured from a deep hole on the north fork near the New Sterling Highway Bridge at RKM 4.2; the rest were captured on the south fork ($n = 8$) and mainstem ($n = 14$). No other species were captured. Of the Chinook salmon marked with caudal clips ($n = 116$) during the 19 June beach seining, a little more than half were observed migrating through the north fork weir ($n = 26$) and the south fork weir ($n = 37$) from 19 June through 12 July. The remaining 53 Chinook salmon were not observed and are assumed to have remained downstream of the weirs.

COUNT DIAGNOSTICS

Between-reader variability was evaluated for 73 DIDSON files (Table 8). The correlation (Kendall's tau) between the primary readers (A and B) was 0.82. Intraclass correlation was also high ($r = 0.96$). Percent agreements were 72.6%. Tukey difference plots indicated disagreements occurred primarily at lower counts (Figure 8).

Within-reader variability was also evaluated for 84 DIDSON files (Table 8). Correlations (Kendall's tau) were 0.91 (reader A) and 0.83 (reader B). Intraclass correlations were 0.97 (reader A) and 0.96 (reader B). Percent agreements were 84.1% (reader A) and only 66.7% (reader B). Tukey difference plots indicated no discernible pattern for disagreements (Figure 9).

RUN TIMING

The midpoint of the Anchor River Chinook salmon run was 19 June (Figure 10, Appendix B1). The middle 80% of the run was counted from 9 June to 12 July (34 days) and daily counts were positively correlated with average river stage over this period ($r = 0.46$, $df = 32$, $P = 0.0054$; Figure 11); there was no indication that daily counts and average river temperature were correlated over this period ($r = -0.16$, $df = 32$, $P = 0.365$; Figure 12). During video weir operation, peak counts through the north fork and south fork weirs occurred on 7 July when river stage increased approximately 12 cm (Appendices B2, B3, and D1). Average water temperature was marginally negatively correlated ($r = -0.29$, $df = 32$, $P = 0.0928$) with average river stage. During the middle 80% of the run, river stage averaged 34.5 cm (range 27.5–45.2 cm) and river temperature averaged 12.0°C (range 9.4–15.6°C; Appendices D1 and D2).

Daily counts of the first 25 percentile (13 May to 13 June) were negatively correlated with average stage ($r = -0.719$, $df = 30$, $P < 0.001$) and positively correlated with average temperature ($r = 0.831$, $df = 30$, $P < 0.001$).

During the DIDSON operation, 53.0% of the fish were counted moving upstream from 0000 to 0759 hours and 47.5% were counted moving downstream during the same period (Figure 13). During the video weir operation on the south fork, 52.7% of the Chinook salmon were counted moving upstream through the video box from 0000 to 0759 hours, whereas 47.4% were counted moving upstream through the north fork video box for this same period (Figure 14).

BIOLOGICAL DATA

The age and sex composition were estimated from 239 samples of which 45 age-sex samples were collected during the DIDSON period and 194 during the weir period. Ocean-age-3 was the dominant age class (43.5%, SE 4.1%; Table 9). Ocean-age-2 was the dominant age class for males (28.0%, SE 3.8%), whereas ocean-age-3 was the dominant age class for females (18.4%, SE 2.5%). Ocean age differed significantly between the north fork and south fork during the sonar period ($\chi^2 = 11.44$, $df = 3$, $P = 0.01$). No such difference between the forks was found during the weir period ($\chi^2 = 3.12$, $df = 3$, $P = 0.37$). A significant difference in age composition was found between beach seine and weir collection samples (south fork weir period) ($\chi^2 = 21.8$, $df = 3$, $P < 0.001$). Ocean age was not significantly different (at 5% level) between weir and sonar periods ($\chi^2 = 7.4$, $df = 3$, $P = 0.06$). The overall mean length of males (604 mm, SE 15 mm) was significantly different to that of females (734 mm, SE 25 mm; $P < 0.001$).

The sex of 2,339 Chinook salmon was determined using video images ($n = 2,090$), live box sampling ($n = 34$), and beach seine samples ($n = 215$). The overall estimated male to female ratio was 3.18:1. There were no significant differences in sex composition by location (north fork vs. south fork) during the sonar period ($\chi^2 = 0.302$, $df = 1$, $P = 0.583$) nor during the weir period ($\chi^2 = 0.782$, $df = 1$, $P = 0.377$). No significant difference in sex composition was found between beach seine and weir collection samples (weir period) ($\chi^2 \approx 0$, $df = 1$, $P = 1$). However, there was a significant difference in sex composition between the sonar and weir periods ($\chi^2 = 7.2$, $df = 1$, $P = 0.007$).

ADIPOSE FIN INSPECTION

No hatchery strays were detected based on the presence of an adipose fin on all 254 Chinook salmon captured during netting.

DISCUSSION

The 2013 estimated escapement of 4,401 Chinook salmon was within the sustainable escapement goal (SEG) range (3,800–10,000) but was the third lowest since 2003 (Table 4). The overall run size was below the 2003–2012 average of 7,274 fish but was like the 2009–2012 average of 3,990 fish. In 2013, overall Chinook salmon run timing was later than average, which delayed reaching the SEG until 10 July.

Emergency orders (EOs) that restricted the LCIMA Chinook salmon sport fisheries were issued preseason in response to the recent years of below-average Anchor River Chinook salmon runs and the uncertainty in how much and how quickly the runs might rebound. The preseason EOs were designed to provide more days of fishing opportunity and to reduce inseason disruptions to the Anchor River Chinook salmon fishery. Preseason EOs closed the 5 Wednesday openings, extended the closed area downstream of the Anchor River sonar-weir site by 1,000 feet, set a combined annual limit of 2 Chinook salmon for the Anchor River, Deep Creek, Ninilchik River, and the saltwater areas between the latitude of Bluff Point and the mouth of the Ninilchik River, restricted gear to 1 unbaited single-hook artificial lure, and required anglers to stop fishing after harvesting a Chinook salmon on the Anchor River, Deep Creek, or Ninilchik River. Inseason projections were used to assess the run's ability to achieve the SEG. An inseason EO (2-KS-8-18-13) closed the fifth opening weekend through 15 July and prohibited Chinook salmon fishing within 1 mile of shore from Bluff Point to the Ninilchik River through 15 July due to the projection of not reaching the lower end of the SEG.

Based on angler reports, fishing success was poor prior to the closure and was probably impacted by poor water conditions going into the fourth weekend. Some anglers reported better catches on Sunday and Monday of the fourth weekend. The 2013 SWHS estimated Chinook salmon harvest from the Anchor River was 97 (SE 100) fish, giving an estimated exploitation of 2.2% (Table 4).

Future escapement monitoring will continue at the south fork and north fork sites established in 2013. Through increased crew efficiencies and use of underwater video systems, the amount of staffing needed to conduct monitoring was the same as at the old mainstem site. The added advantage of monitoring on both forks is the increased resolution of the escapement (i.e., proportion by fork). DIDSON may be required on the south fork in years with high spring runoff, but the north fork will allow underwater video weir monitoring from the start.

In 2013, it was challenging to collect ASL samples. The high flows that altered the mainstem escapement site also altered other reaches of the south and north forks. In the past, many of these reaches were used reliably to capture Chinook salmon for ASL sampling, but were too altered in 2013. In addition, because the use of the underwater video system allowed fish to pass the weir continuously, it has become more difficult to collect ASL samples in the live box (historically the weir was operated with a live box from 0800 to 2300 hours, causing fish to accumulate during closed times). Chinook salmon seemed to avoid entering the live box when the passage was closed. A better option proved to be the collection of ASL samples using nets downstream of the weir. It is recommended that future ASL sampling should be done downstream of the weir sites in the mainstem when possible and until Dolly Varden begin to enter the river in high numbers (about mid-July, just before peak spawning of Chinook salmon).

The return of ocean-age-4 Chinook salmon in 2013 marked the final adult return from brood year (BY) 2007 and the fourth year that production could be fully assessed. The return (4,895 fish) from the 2007 escapement (9,622, SE 238) was 0.51, which is below a 1:1 replacement (Tables 10 and 11). The BY 2007 return per spawner is like BYs 2005 and 2006 (0.46 and 0.44, respectively), but much greater than BY 2004 (0.29). The escapements in both 2004 and 2005 were above 10,000 fish, which is the carrying capacity based on the current full probability model used to establish the SEG (Szarzi et al. 2007), but the escapements in 2006 and 2007 were slightly below the modelled carrying capacity (Table 4). It is expected that with additional years of production data, the low production of BYs 2004–2007 can be more thoroughly evaluated by comparing production from contrasting low and high escapements.

The 2013 run timing was more like the average timing of the later, smaller size runs that have been occurring since 2009 than the average run timing of the earlier, larger size runs occurring from 2004 to 2008 (Figure 10). It is unknown to what extent changes in temperature or food availability in the marine environment may have in slowing growth and maturation of returning fish but shifts in these conditions may contribute to shifts in run timing.

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TABLES

Table 1.—Drainage characteristics of the north and south forks of the Anchor River.

Drainage characteristics	Anchor River		
	North fork	South fork	Total
Watershed area (km ²)	181	405	587
Wetland area (km ²)	93	189	282
Percent wetland	51	47	48
Stream length (RKM)	149	352	501
Anadromous stream length (RKM)	90	176	266

Source: S. Baird, Research Analyst, Kachemak Bay Research Reserve in Homer, AK, unpublished data, 2006.

Note: “RKM” means river kilometers.

Table 2.—Statewide Harvest Survey estimates of Chinook salmon harvest and catch compared to the number of days open to harvest for Anchor River Chinook salmon, 1977–2013.

Year	Chinook salmon			Chinook salmon opening days			Harvest	
	Harvest		Catch	Weekend days ^a			Total days ^d	Harvest per day
	Estimate	SE		Before MD ^b	On and after MD ^c	Wednesdays		
1977	1,077	—	NA	0	8	0	8	135
1978	2,109	—	NA	0	12	0	12	176
1979	1,913	—	NA	0	12	0	12	159
1980	605	—	NA	0	12	0	12	50
1981	1,069	—	NA	0	12	0	12	89
1982	718	—	NA	0	12	0	12	60
1983	1,269	—	NA	0	12	0	12	106
1984	998	—	NA	0	12	0	12	83
1985	672	—	NA	0	12	0	12	56
1986	1,098	—	NA	0	12	0	12	92
1987	761	—	NA	0	12	0	12	63
1988	976	—	NA	0	15	0	15	65
1989	578	—	NA	0	15	0	15	39
1990	1,479	—	4,119	0	15	0	15	99
1991	1,047	—	2,540	0	15	0	15	70
1992	1,685	—	4,506	0	15	0	15	112
1993	2,787	—	6,022	0	15	0	15	186
1994	2,478	—	3,890	0	15	0	15	165
1995	1,475	—	3,545	0	15	0	15	98
1996	1,483	20	6,594	0	15	0	15	99
1997	1,563	18	5,289	0	15	0	15	104
1998	783	11	2,443	0	15	0	15	52
1999	1,409	19	6,903	0	15	0	15	94
2000	1,730	19	5,200	0	15	0	15	115
2001	889	16	2,415	0	15	0	15	59
2002	1,047	19	4,103	0	12	0	12	87
2003	1,011	15	4,311	0	12	0	12	84
2004	1,561	19	5,561	0	15	0	15	104
2005	1,432	23	5,028	3	12	0	15	95
2006	1,394	19	4,638	3	12	0	15	93
2007	2,081	32	9,792	3	12	0	15	139
2008	1,486	24	3,245	3	12	5	20	74
2009	737	21	2,296	3	6	3	12	61
2010	364	11	889	3	6	3	12	30
2011	573	16	1,227	3	6	3	12	48
2012	38	23	189	3	6	0	9	4
2013	97	55	423	3	9	0	12	8
Averages								
2003–2012	1,068	18	3,718	2	10	1	14	73
1977–2012	1,233	18	4,119 ^e	1	12	0	14	90

-continued-

Table 2.—Page 2 of 2.

Source: Alaska Sport Fishing Survey database [Internet]. 1996–present. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish (cited August 2015). Available from: <http://www.adfg.alaska.gov/sf/sportfishingsurvey/>.

Note: “Harvest” is number of fish kept, “catch” is fish harvested plus released, “NA” means not applicable, and an en dash means not calculated.

^a Weekend openings consisted of Saturday and Sunday from 1977 to 1987 and Saturday–Monday since 1988.

^b Before the Memorial Day weekend.

^c On and after the Memorial Day weekend.

^d Days open for Chinook salmon harvest (regulatory openings adjusted by emergency orders as needed).

^e Average for 1990–2012.

Table 3.—Anchor River weir and DIDSON fish counts by species, 1987–1995 and 2003–2013.

Year	Project dates	Location (RKM) ^a	Method	Fish counts						
				Chinook salmon ^b	Dolly Varden ^c	Pink salmon ^c	Chum salmon	Sockeye salmon	Coho salmon ^d	Rainbow trout and steelhead ^e
1987 ^f	Jul 04–Sep 10	1.6	fixed picket weir	204	19,062	2,084	19	33	2,409	136
1988 ^f	Jul 03–Oct 05	1.6	fixed picket weir	245	14,935	777	24	30	2,805	878
1989 ^f	Jul 06–Nov 05	1.6	resistance board weir	95	11,384	4,729	165	212	20,187	769
1990 ^f	Jul 04–Aug 15	1.6	resistance board weir	144	10,427	355	17	39	190	3
1991 ^f	Jul 04–Aug 15	1.6	resistance board weir	39	18,002	1,757	9	46	13	5
1992 ^f	Jul 04–Oct 01	1.6	resistance board weir	129	10,051	992	39	174	4,596	1,261
1993 ^f	Jul 03–Aug 16	1.6	resistance board weir	90	8,262	1,019	12	71	290	1
1994 ^f	Jul 03–Aug 16	1.6	resistance board weir	111	17,259	723	2	61	420	1
1995 ^f	Jul 04–Aug 12	1.6	resistance board weir	112	10,994	1,094	4	73	725	10
2003 ^g	May 30–Jul 09	2.8	DIDSON	9,238 ^h	—	—	—	—	—	—
2004 ^g	May 15–Sep 13	2.8	DIDSON, resist. board weir	12,016 ^{h,i}	7,846	1,079	79	45	5,728	20
2005 ^g	May 13–Sep 09	2.8	DIDSON, resist. board weir	11,156 ^{h,i}	5,719	4,916	146	319	18,977	107
2006 ^{g,j}	May 15–Aug 24	2.8	DIDSON, resist. board weir	8,945 ^{h,i}	234	954	45	38	10,181	4
2007 ^g	May 14–Sep 12	2.8	DIDSON, resist. board weir	9,622 ^{h,i}	1,309	3,916	156	200	8,226	325
2008 ^g	May 13–Sep 11	2.8	DIDSON, resist. board weir	5,806 ^{h,i}	1,344	2,017	66	52	5,951	258
2009 ^g	May 12–Sep 11	2.8	resistance board weir	3,455	1,404	4,975	68	62	2,692	54
2010 ^g	May 13–Sep 29	2.8	DIDSON, resist. board weir	4,449 ^{h,i}	1,352	972	67	212	6,014	586
2011 ^g	May 13–Sep 21	2.8	DIDSON, resist. board weir	3,545 ^{h,i}	1,523	2,169	60	47	1,866	132
2012 ^g	May 14–Aug 03	2.8	DIDSON, resist. board weir	4,509 ^{h,i}	2,125	321	27	6	32	1
2013	May 15–Aug 03	^k	DIDSON, resist. board and fixed picket weir	4,401	1,523	950	27	6	1	1

^a River kilometers (RKM) from mouth of the Anchor River.

^b Chinook salmon counts represent escapement because there is no harvest above the monitoring site. The run was only partially counted in 1987–1995 due to weir operation dates and location, and in 2003 due to weir operation dates.

^c Incomplete Dolly Varden–pink salmon counts due to picket spacing of the weir (2004–2008) because smaller fish were able to pass through the weir pickets undetected.

^d Incomplete coho salmon counts because the project operation dates did not span entire run (1991, 1993–1995, 2005–2006, 2012).

^e Incomplete trout counts due to project operation dates or weir location (1987, 1990–1991, 1993–1995, 2004–2009, 2012, 2013). Cumulative counts from July 1 through end of weir operation.

^f Source for 1987: Larson et al. (1988); 1988: Larson and Balland (1989); 1989: Larson (1990); 1990: Larson (1991); 1991: Larson (1992); 1992: Larson (1993); 1993: Larson (1994); 1994: Larson (1995); 1995: Larson (1997), when escapement weir was located approximately 1.6 RKM from mouth.

^g Source for 2003–2004: Kerkvliet et al. (2008); 2005–2006: Kerkvliet and Burwen (2010); 2007–2008: Kerkvliet et al. (2012); 2009: Kerkvliet and Booz (2012). 2010–2012: Kerkvliet and Booz (2018a, 2018b, 2018c).

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- ^h All DIDSON images and the associated counts were assumed to be Chinook salmon.
- ⁱ Chinook salmon estimates based on combined DIDSON and weir census. If DIDSON was operated in July, counts were apportioned between large fish (Chinook salmon) and small fish (Dolly Varden and pink salmon).
- ^j No counts were collected from 19 to 21 August because the weir washed out due to flooding. The DIDSON was operated again from 22 to 24 August; an estimated 3,292 coho salmon were counted.
- ^k Site used from 2003 to 2012 was unsuitable for monitoring due to high flows. DIDSON was operated about 300 m downstream of the 2.8 RKM mainstem site. Once flows allowed weir installation, monitoring was relocated and split into 2 sites upstream of the mainstem site at 2.8 RKM. A resistance board weir was used to monitor escapement at RKM 4.0 on the south fork and a fixed picket weir was used at RKM 5.3 on the north fork.

Table 4.—Anchor River Chinook salmon escapement, freshwater harvest, total run, and exploitation estimates, 2003–2013.

Year	Escapement goal ^a	Project dates	Escapement		Inriver harvest		Total inriver run ^b	
			Estimate	SE	Estimate	SE	Estimate	Exploitation rate (%) ^a
2003	750–1,500	May 30–Jul 09	9,238 ^c	0	1,011	157	10,249	9.9 ^d
2004	750–1,500	May 15–Sep 15	12,016 ^e	283	1,561	198	13,577	11.5
2005	No goal	May 13–Sep 09	11,156 ^e	229	1,432	233	12,588	11.4
2006	No goal	May 15–Aug 24	8,945 ^e	289	1,394	197	10,339	13.5
2007	No goal	May 14–Sep 12	9,622 ^e	238	2,081	326	11,703	17.8
2008	5,000	May 13–Sep 12	5,806 ^e	169	1,612	241	7,418	21.7
2009	5,000	May 12–Sep 11	3,455 ^f	0	737	212	4,192	17.6
2010	5,000	May 13–Sep 29	4,449 ^e	103	364	118	4,813	7.6
2011	3,800–10,000	May 13–Sep 21	3,545 ^e	0	573	163	4,118	13.9
2012	3,800–10,000	May 14–Aug 3	4,509 ^e	100	38	100	4,547	0.8
2013	3,800–10,000	May 15–Aug 3	4,401 ^e	117	97	55	4,498	2.2
Average								
2009–2012			3,990		428		4,418	10.0
2003–2012			7,274		1,080		8,354	12.6

Source: Harvest estimates from Alaska Sport Fishing Survey database [Internet]. 1996–present. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish (cited August 2015). Available from: <http://www.adfg.alaska.gov/sf/sportfishingsurvey/>.

^a Sustainable escapement goal (SEG) used to manage the fishery. The 2003 and 2004 SEG based on aerial index count (Otis and Hasbrouck 2004). The 2008–2011 SEG is based on a Ricker recruitment model (Szarzi et al. 2007; Otis et al. 2010).

^b “Total inriver run” is escapement plus freshwater harvest; total does not account for the marine harvest.

^c Estimate is based on a census of all DIDSON files. Escapement was not fully assessed due to operation dates did not spanning the entire run.

^d Exploitation is conservative because escapement was not fully enumerated.

^e Estimate is based on expanded DIDSON counts and weir counts.

^f Escapement is based on weir counts.

Table 5.—Monitoring of Anchor River Chinook salmon by location, date, and hour, 2013.

Monitoring duration	Bridge Hole DIDSON	South fork weir	North fork weir
Start	19 May at 1900 h	19 June at 1300 h	19 June at 1300 h
Stop	19 June at 1200 h	3 August 2359 h	3 August 2359 h

Table 6.— Locations of major sampling landmarks and beach seine reaches on the Anchor River.

Waters and beach seine reach code	Reach description and landmarks	River kilometer		
		From	Location	To
Mainstem	Anchor River mouth		0.0	
A	Mainstem reach (2012–2013)	3.7		1.7
	End of beach seine reach A		1.7	
	Bridge Hole; DIDSON site (2013); start of beach seine reach A		3.7	
	Old Sterling Hwy Bridge		3.8	
	Old DIDSON-weir site (2003–2012)		3.9	
	North and south forks confluence		4.0	
North fork	New Sterling Highway Bridge		4.2	
B	North Fork reach (2003–2013)	5.5		4.4
	End of beach seine reach B		4.4	
	North fork weir site (2013)		5.4	
	North fork bridge; start of beach seine reach B		5.5	
South fork				
C	South Fork reach (2003–2013)	9.7		3.9
	South fork DIDSON-weir site (2013)		4.1	
	Start of beach seine reach C		9.7	
	New Sterling Highway		11.9	
D	South Fork upper reach (2013)	18.4		14.4
	End of beach seine reach D		14.4	
	Start of beach seine reach D		18.4	

Table 7.—Species composition of beach seine catches from sampling on the north and south forks and mainstem Anchor River, 2013.

Waters	Sample dates	Reach code ^a	Chinook salmon	Steelhead	Dolly Varden	Pink salmon	Coho salmon
Mainstem	11 Jul	A	19	0	4	31	0
North fork	22 May	B	0	2	0	0	0
	31 May	B	7	0	0	0	0
	7 Jun	B	28	3	0	0	0
	9 Jul	B	23	0	0	0	0
	Total		58	5	0	0	0
South fork	6 Jun	C	19	3	0	0	0
	20 Jun	C	60	1	0	0	0
	8 Jul	C	54	1	0	2	1
	17 Jul	D	29	0	8	3	0
	Total		162	5	8	5	1

^a See Table 6 for reach code definitions.

Table 8.—Between- and within-reader correlation analyses for DIDSON counts, Anchor River, 2013.

Analysis	Reader combination	Number of files	Accumulated counts		Kendall's tau	Intraclass correlation (<i>r</i>)	Intraclass 95% CI	Percent agreement
			First reader	Second reader				
Between reader	A–B	73	29	50	0.82	0.96	0.934, 0.979	72.6
Within reader	A–A	63	18	23	0.91	0.97	0.944, 0.979	84.1
	B–B	21	50	46	0.83	0.96	0.904, 0.983	66.7
	Overall	84	68	69	0.89	0.96	0.949, 0.975	79.8

Table 9.—Estimated ocean age, sex, and length composition of the Anchor River Chinook salmon escapement, 2013.

Sex	Parameter	Composition by ocean age ^a					Composition by sex ^a
		1	2	3	4	Total	
Female							
	Number of samples	0	6	50	3	59	766
	Estimated percent	NA	3.7	18.4	1.8		23.9
	SE percent	NA	1.7	2.5	1.2		2.5
	Estimated abundance	NA	163	808	81		1,052
	SE abundance	NA	75	112	53		113
	Length samples	NA	6	50	3		59
	Mean length (mm)	NA	595	777	766		734
	SE mean length	NA	17	9	23		25
Male							
	Number of samples	37	65	52	4	158	1,573
	Estimated percent	20.2	28.0	25.2	2.7		76.1
	SE percent	3.6	3.8	3.8	1.6		2.5
	Estimated abundance	889	1,232	1,108	120		3,349
	SE abundance	160	170	170	70		142
	Length samples	35	62	49	4		150
	Mean length (mm)	360	583	766	847		604
	SE mean length	8	7	8	60		15
All							
	Number of samples	39	76	116	8	239	2,339
	Estimated percent	20.4	31.5	43.5	4.6		
	SE percent	3.6	3.9	4.1	2		
	Estimated abundance	898	1,386	1,914	202		4,401
	SE abundance	160	175	187	88		117
	Length sampled	35	68	99	7		209
	Mean length (mm)	360	584	767	836		635
	SE mean length	8	6	6	26		14

Note: "NA" means not available.

^a Age, sex, and length-at-age compositions are calculated by weighting DIDSON period estimates (pooled north and south fork beach seine samples) and weir-based estimates (pooled north and south fork weir samples along with samples from 1 day of beach seining in the mainstem).

Table 10.—Anchor River Chinook salmon estimated escapement and freshwater harvest by ocean-age composition, 2003–2013.

Run year	Escapement										Freshwater harvest					
	Estimate	SE	Percent by ocean age				Number of fish by ocean age				Number of fish					
			1	2	3	4	1	2	3	4	Estimate	SE	Ocean age			
													1	2	3	4
2003 ^a	9,238	0	5	23	58	14	471	2,125	5,340	1,275	1,011	157	52	233	584	140
2004	12,016	283	9	21	49	22	1,057	2,487	5,840	2,632	1,561	198	137	323	759	342
2005	11,156	229	5	24	52	19	558	2,666	5,823	2,108	1,432	233	72	342	748	271
2006	8,945	289	6	17	52	25	572	1,476	4,660	2,236	1,394	197	89	230	726	349
2007	9,622	238	1	22	53	24	48	2,116	5,138	2,319	2,081	326	10	458	1,111	502
2008	5,806	169	4	22	69	5	255	1,266	3,977	302	1,612	241	71	351	1,104	84
2009	3,455	0	8	51	37	4	269	1,766	1,268	152	737	212	57	377	270	32
2010	4,449	103	7	36	51	6	311	1,606	2,282	249	364	118	25	131	187	20
2011	3,545	0	3	50	41	6	113	1,773	1,457	202	573	163	18	287	236	33
2012	4,509	100	11	34	50	5	487	1,547	2,273	203	38	23	4	13	19	2
2013	4,401	117	20	32	44	5	898	1,386	1,914	202	97	55	20	31	42	4
Average																
2003–2013	7,013	139	7	30	51	12	458	1,838	3,634	1,080	991	175	51	252	526	162

^a Escapement was not fully assessed due to operation dates.

Table 11.—Anchor River Chinook salmon return per spawner by brood year, 2003–2013.

Brood year	Number of fish returning by brood year			Return per spawner ^a
	Escapement by brood year	Freshwater harvest	Total return	
2003	6,817	1,684	8,501	0.92 ^b
2004	2,831	653	3,484	0.29
2005	4,505	667	5,172	0.46
2006	3,535	426	3,961	0.44
2007	4,559	336	4,895	0.51
2008	NA	NA	NA	NA
2009	NA	NA	NA	NA
2010	NA	NA	NA	NA
2011	NA	NA	NA	NA
2012	NA	NA	NA	NA
2013	NA	NA	NA	NA

Note: “NA” means not available.

^a See Table 10 for estimates of total number of spawners (escapement) used to calculate return per spawner for each brood year.

^b Biased upward because escapement was not fully assessed.

FIGURES

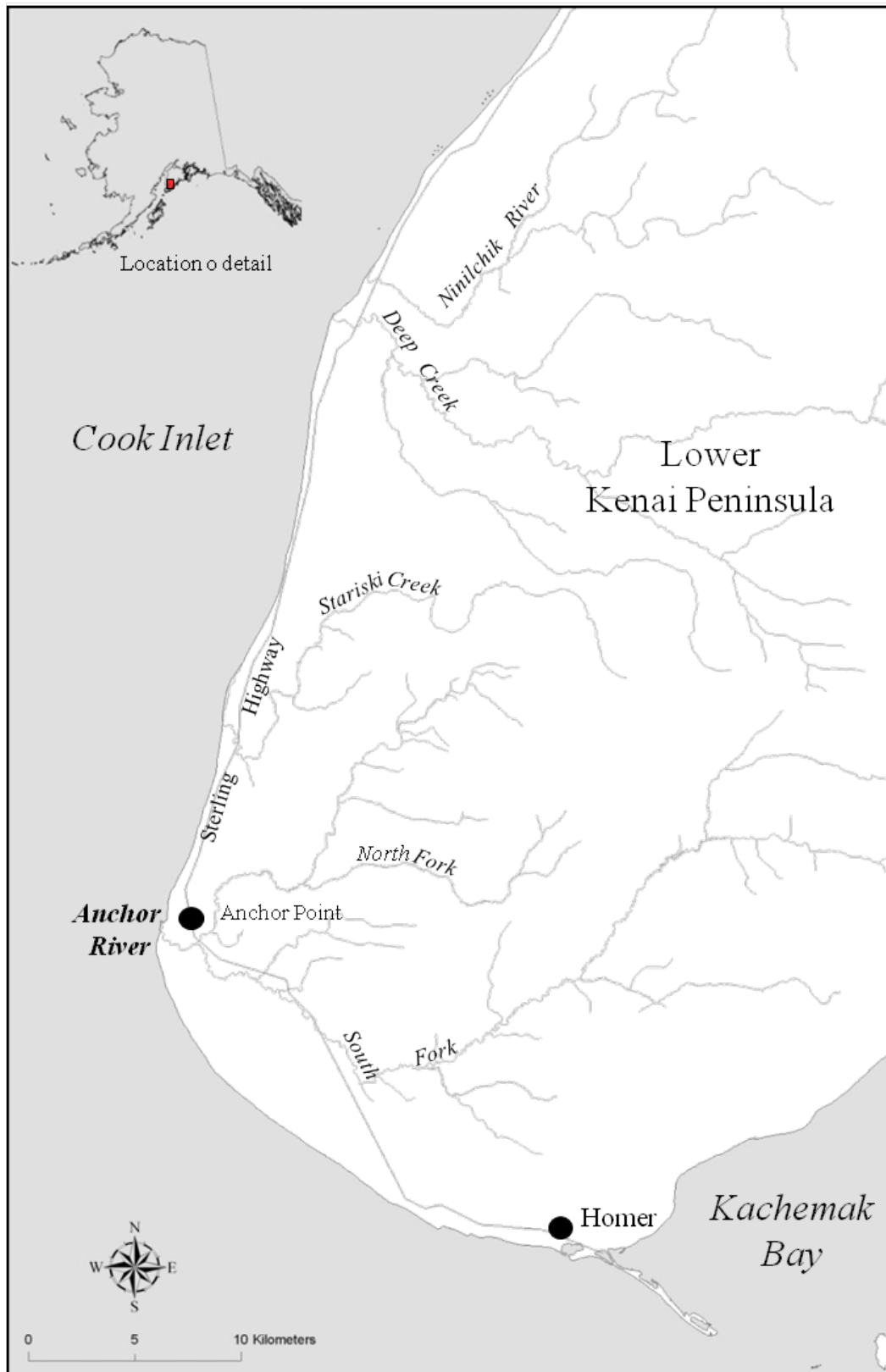


Figure 1.—Location of Anchor River and other roadside tributaries in the Lower Cook Inlet Management Area.



Figure 2.—View of the south fork weir site and its position relative to the 2003–2012 mainstem DIDSON-weir site and Bridge Hole, 2013.



Figure 3.—Location of the mainstem DIDSON-weir site used from 2003 to 2013 and the monitoring sites used in 2013 at Bridge Hole on the mainstem and on the south and north forks of the Anchor River.



Figure 4.—View of the Bridge Hole monitoring site facing downstream from the Old Sterling Highway Bridge (A) and location of the partial picket weir used to narrow the insonified corridor to less than 20 m (B) to allow escapement monitoring using DIDSON, 2013.



Figure 5.—North fork weir on the Anchor River, 2013.



Figure 6.—South fork weir on the Anchor River, 2013.

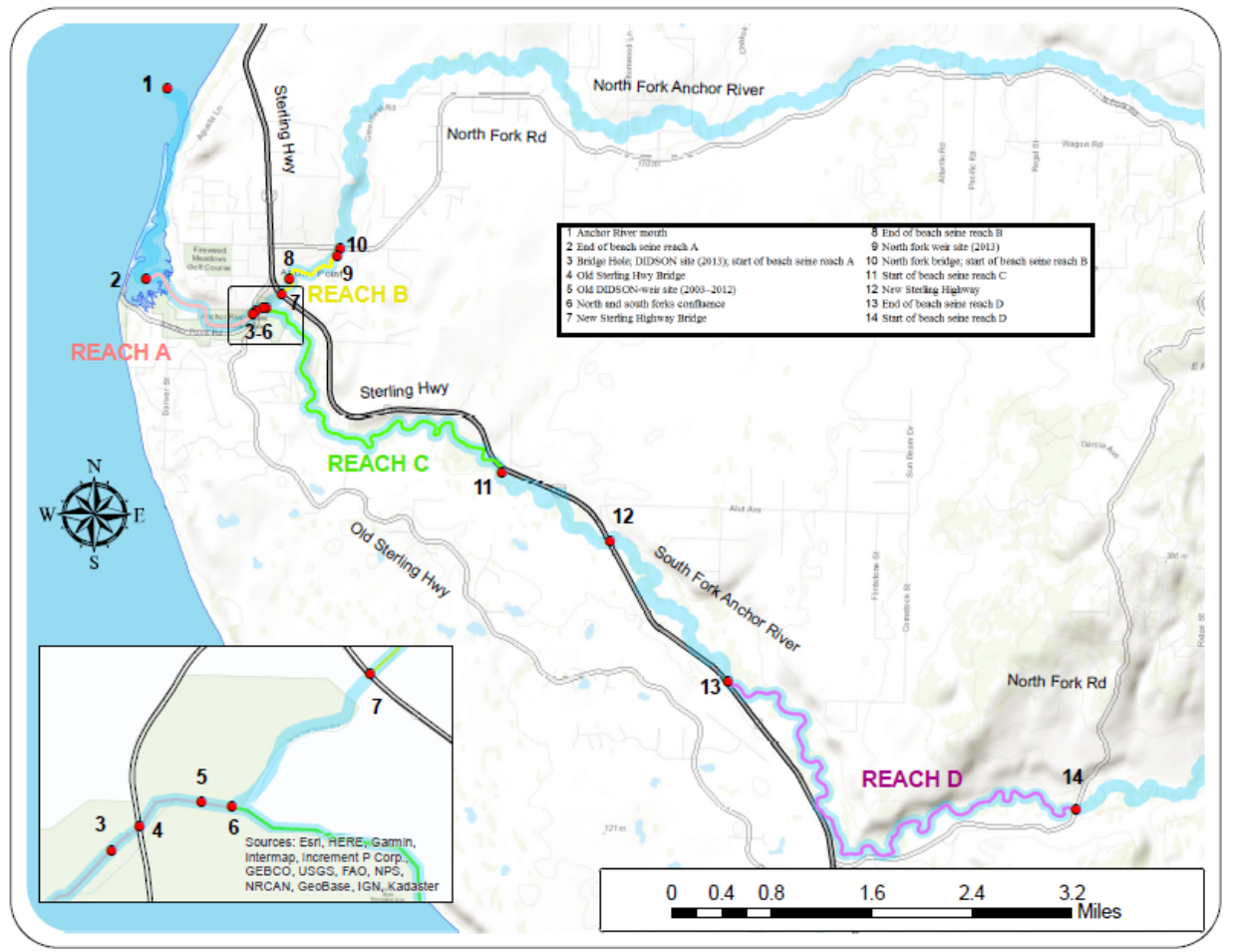


Figure 7.—Locations of major sampling landmarks and beach seine reaches on the Anchor River.

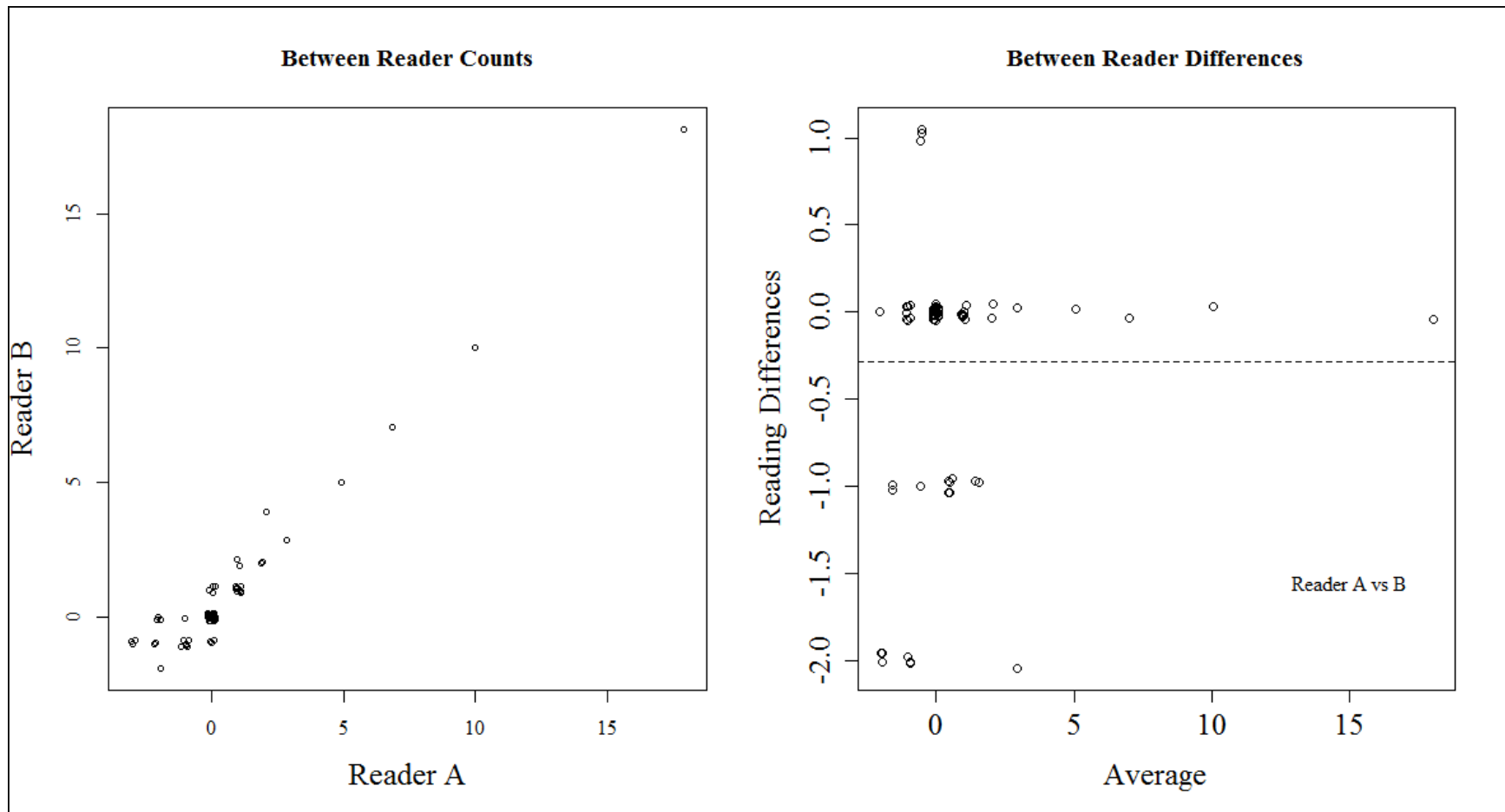


Figure 8.—Between-reader counts (left) and Tukey difference plots (right) for readers of selected DIDSON files, Anchor River, 2013.

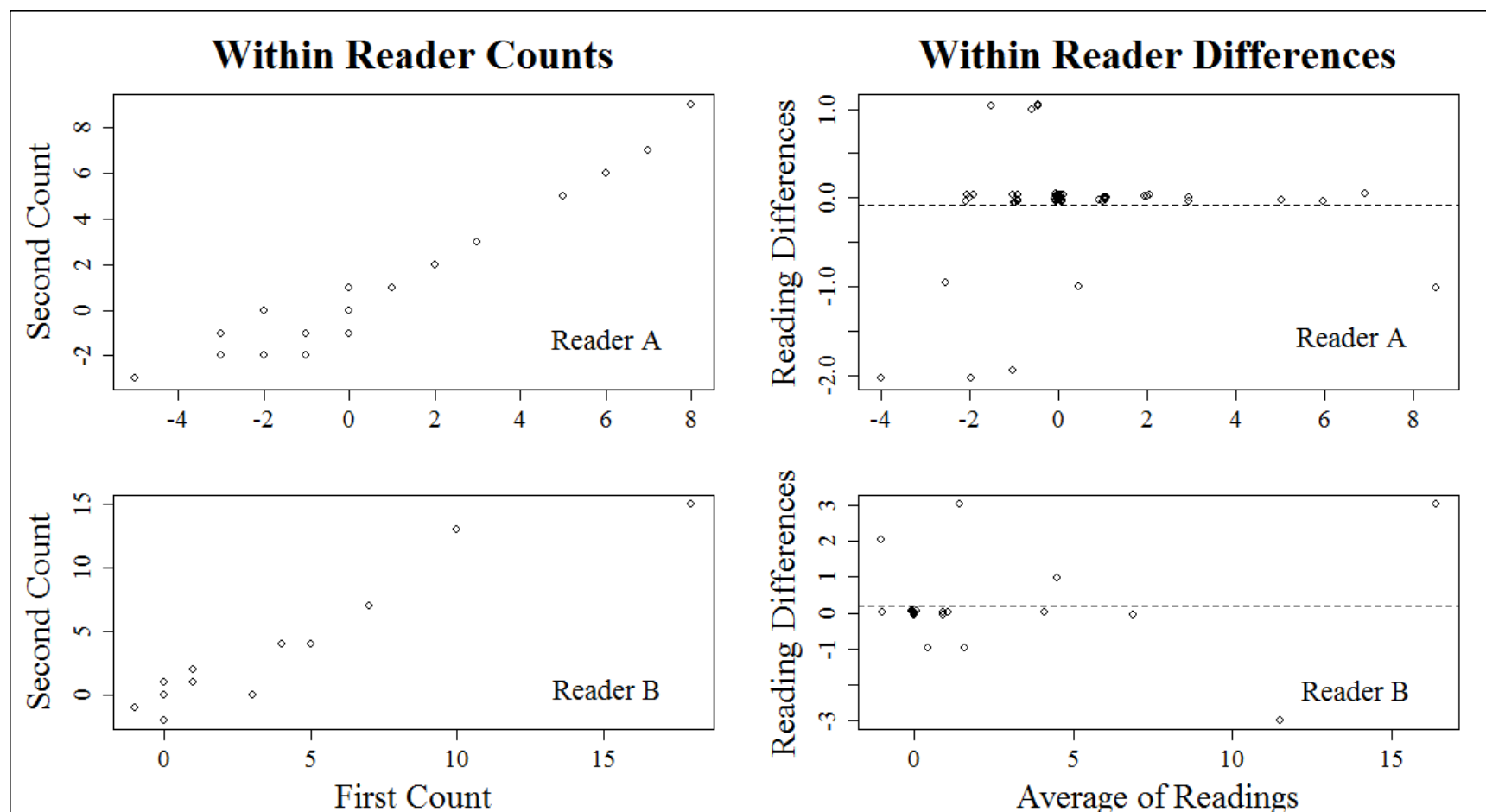


Figure 9.—Within-reader counts (left) and Tukey difference plots (right) for readers of selected DIDSON files, Anchor River, 2013.

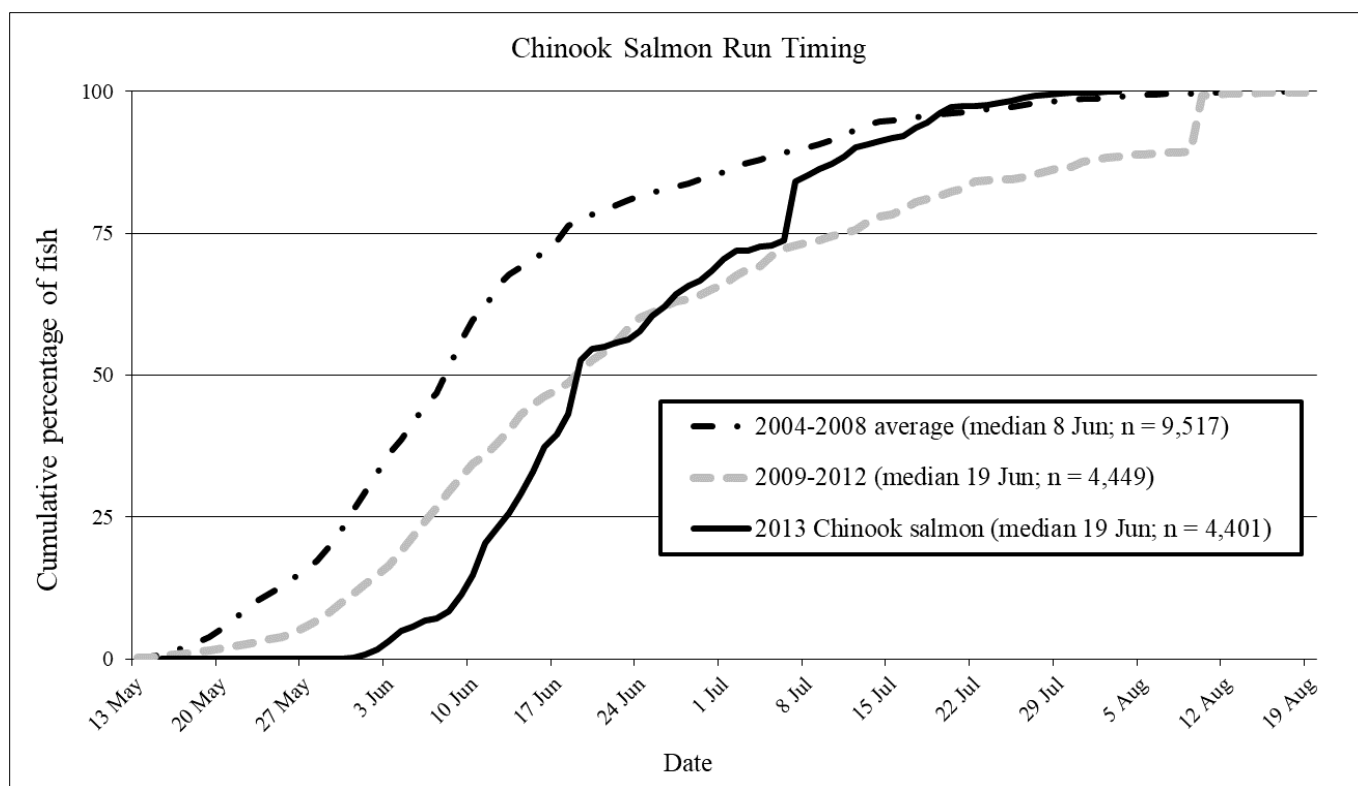


Figure 10.—Chinook salmon run timing of the 2013 Anchor River immigration compared to the 2004–2008 and 2009–2012 averages.

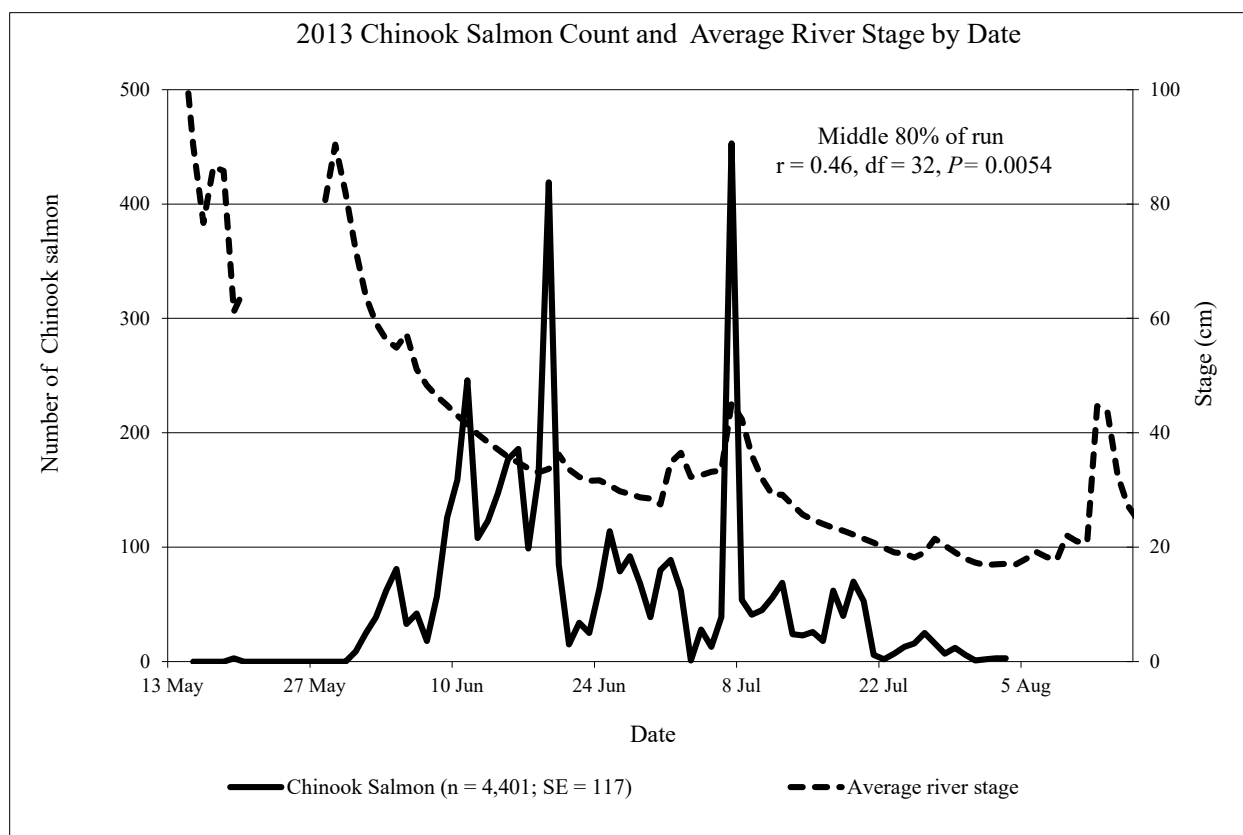


Figure 11.—Estimated daily counts of Chinook salmon at the sonar-weir site plotted against daily river stage averages by date, Anchor River, 2013.

Note: Stage data collected at gauge station USGS 15239900 located at approximately 11.4 RKM on the south fork, Anchor River.

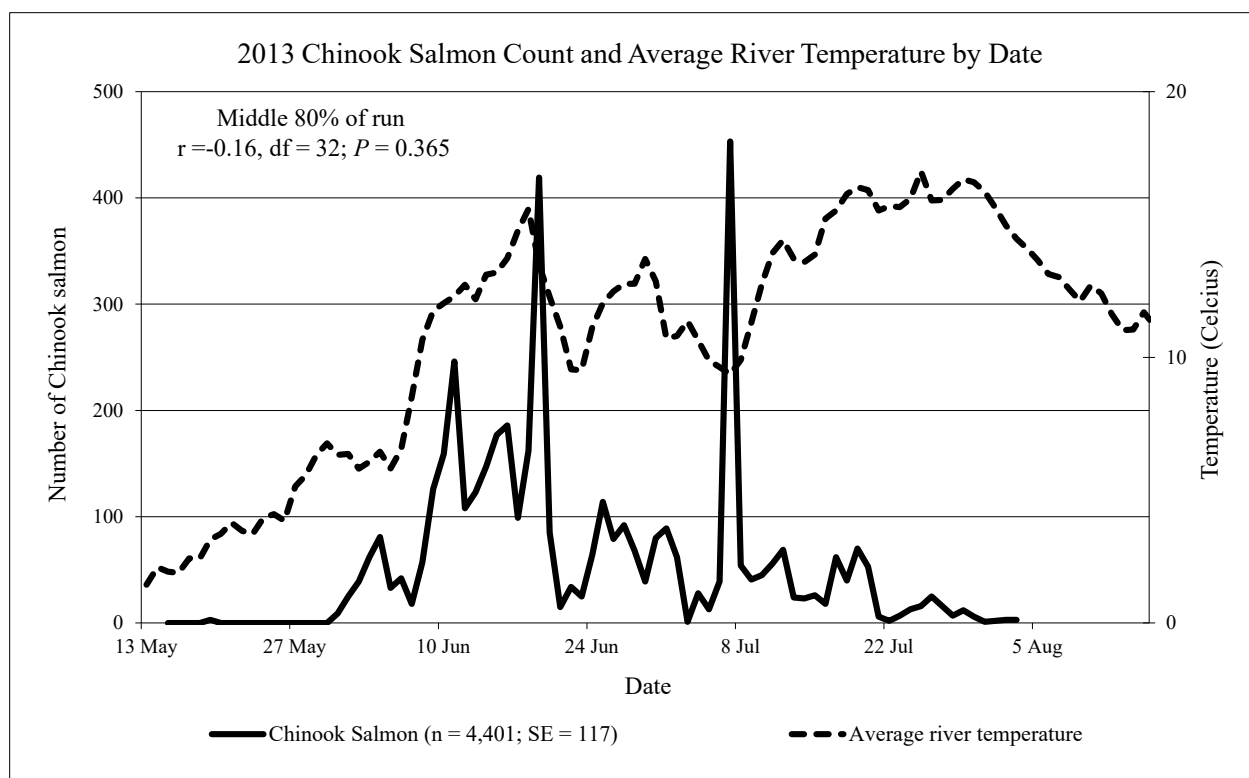


Figure 12.—Daily counts of Chinook salmon at the sonar-weir site plotted against daily river temperature averages by date, Anchor River, 2013.

Note: Temperature data collected approximately 0.1 RKM downstream of the south and north forks confluence of the Anchor River.

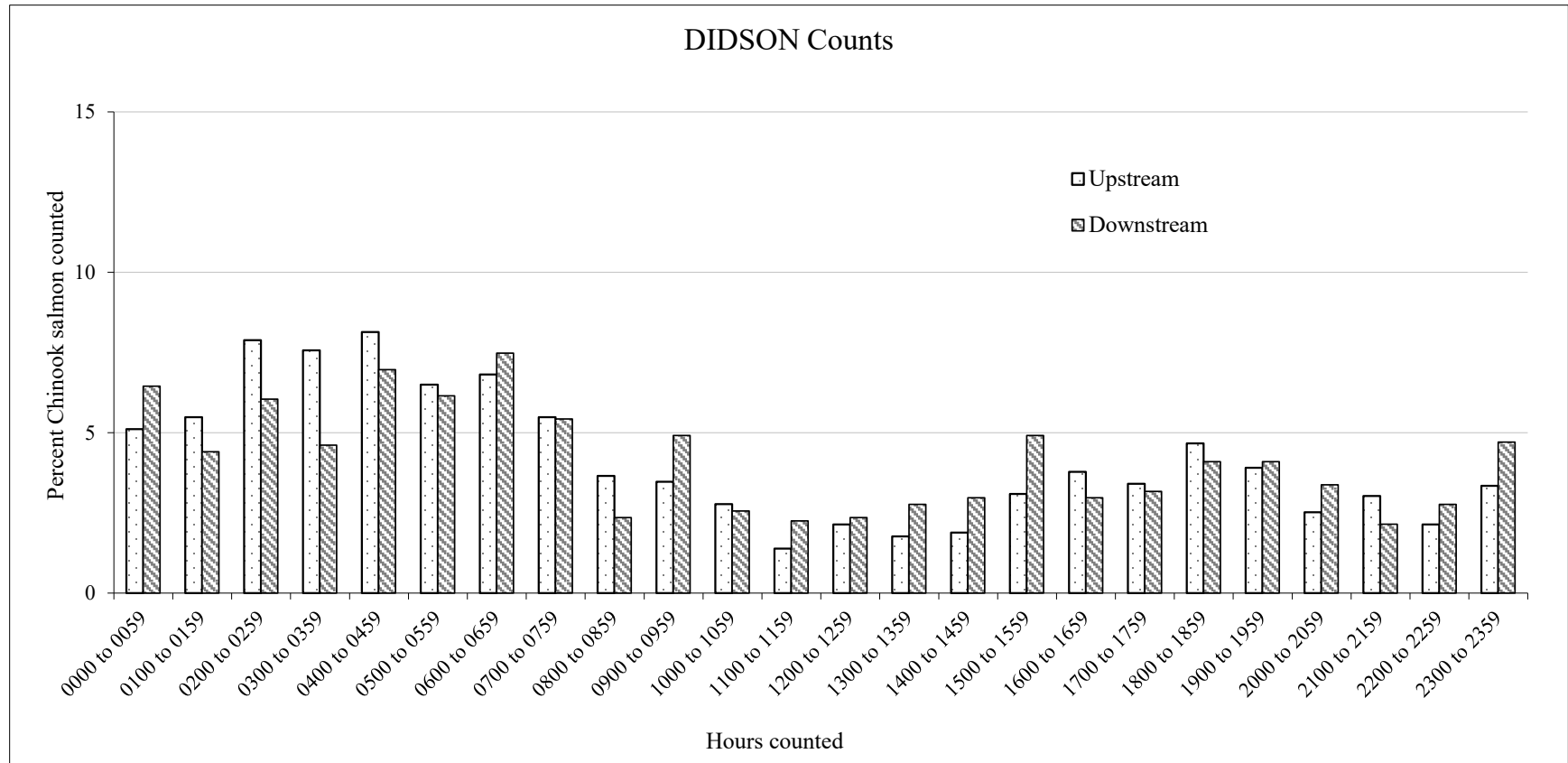


Figure 13.—Percent of all upstream and downstream images by hour from 19 May through 19 June based on DIDSON counts, Anchor River, 2010.

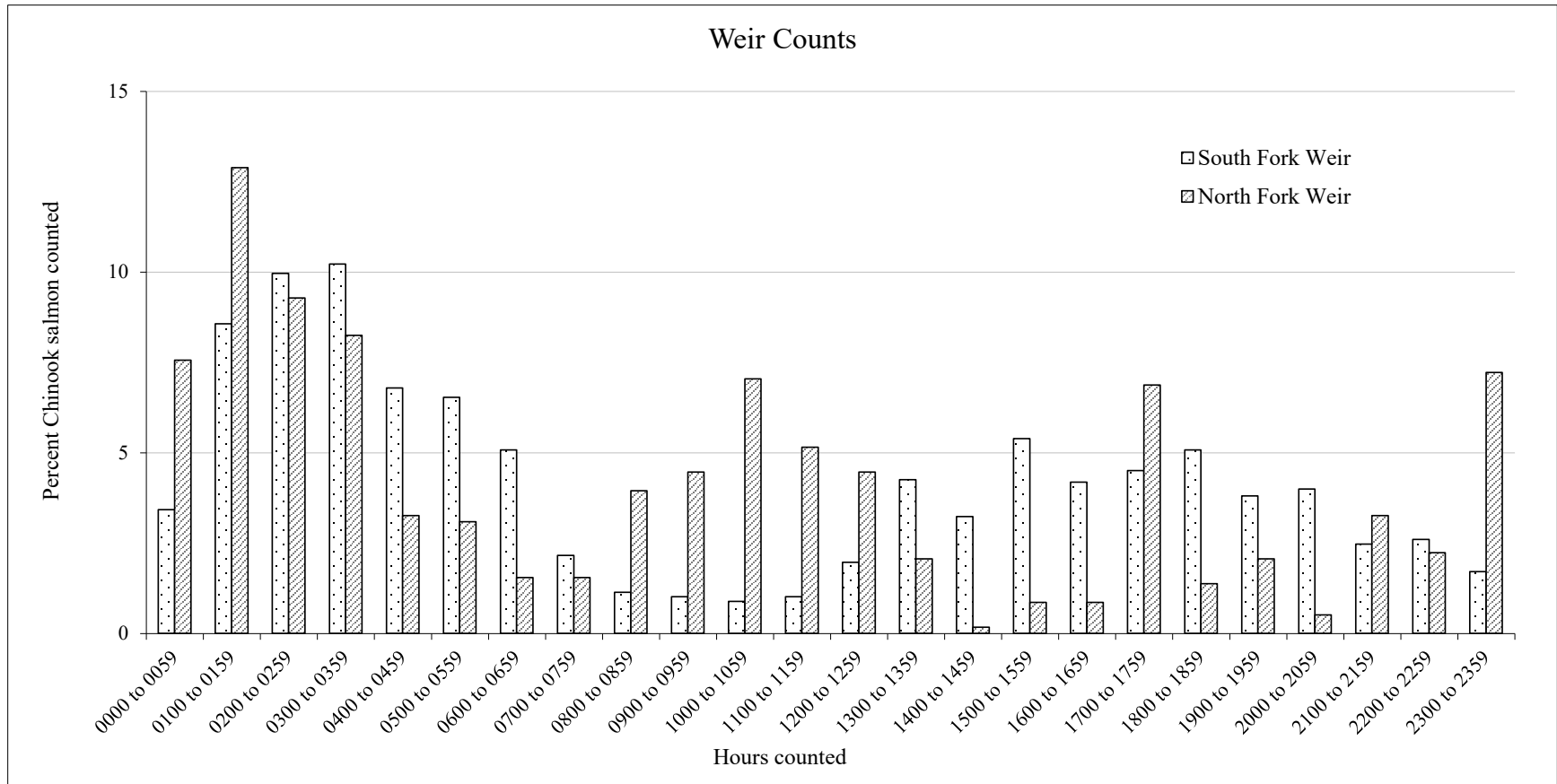


Figure 14.—Percent of Chinook salmon counted by hour moving upstream through the south and north fork video boxes from 19 June through 3 August, Anchor River, 2013.

APPENDIX A: MONITORING TIMELINES FOR ANCHOR RIVER CHINOOK SALMON

Appendix A1.—Timeline of escapement monitoring for Chinook salmon on the Anchor River, 1950–2013.

Year(s)	Escapement monitoring
1950s	Periodic fisheries investigations in the Anchor River were conducted by U.S. Fish and Wildlife Service. Chinook salmon escapement was monitored with weirs at various lower river locations on the north and south forks and the mainstem. Aerial and foot surveys were also conducted.
1962–1969	Annual Chinook salmon escapement was estimated with a combination aerial and ground index survey. Surveys were conducted once annually over a standard length of river. Aerial surveys were done from a fixed-wing aircraft (Super Cub). Foot surveys were conducted within a subsection of the aerial survey from the Sterling Highway Bridge upstream approximately 4 river kilometers (RKM) to forks (assumed to be the confluence). Where the foot survey was conducted, if the foot survey counts were greater than the aerial counts, the total aerial count was expanded by the difference. In 1966, no aerial surveys were conducted due to poor viewing conditions. Note: “standard length” and the location of the Sterling Highway Bridge (old versus new) could not be determined.
1970–1974	The ground index subsection was expanded to approximately 8 RKM from Glanville Lumber to forks. No aerial survey was conducted in 1970 or 1971. Note: “forks” is assumed to be the north and south forks confluence.
1975–1982	Aerial surveys were conducted using rotary-wing aircraft to index Chinook salmon escapement. Surveys were conducted once annually over a standard section of the south fork of the Anchor River. Foot surveys continued as before. Note: “forks” is assumed to be the north and south forks confluence.
1983–1994	The index subsection for combined aerial and foot surveys was reduced back to approximately 4 RKM from Sterling Highway Bridge to forks. Note: “standard length” and the location of the Sterling Highway Bridge (old versus new) could not be determined.
1995–2002	The foot survey was discontinued. Periodic foot surveys were conducted over additional stream reaches such as North Fork, Beaver Creek, and above forks. Aerial surveys continued.
2003	In addition to the aerial survey, the feasibility of using DIDSON ⁵ as an escapement monitoring tool was tested on the mainstem of the Anchor River just below the confluence of the north and south forks at RKM 2.8. DIDSON was only operated from 30 May through 9 July, not over the entire run.
2004	Chinook salmon escapement was monitored over the entire run at approximately RKM 2.8 through a combination of DIDSON during periods of high water and resistance board weir during periods of low water. A weir was operated on the north fork to monitor the entire run at approximately RKM 6.2. Aerial surveys of the north fork and south fork index areas were used to compare index to total escapement estimates.
2005–2008	Chinook salmon escapement was monitored over the entire run at approximately RKM 2.8 through a combination of DIDSON during periods of high water and resistance board weir during periods of low water. Aerial surveys were continued through 2008 to compare index to total run estimates.
2009	Chinook salmon escapement was censused using a resistance board weir over the entire run at approximately RKM 2.8 because of low water levels. A foot survey of the historical index area was conducted from the new Sterling Highway Bridge (lat 59.746895, long –151.754319) to the confluence of the North and South Forks (lat 59.772253, long –151.834263).

–continued–

⁵ Dual-frequency identification sonar (DIDSON).

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Year(s)	Escapement monitoring
2010	Chinook salmon escapement was monitored over the entire run at approximately RKM 2.8 through a combination of DIDSON during periods of high water and resistance board weir during periods of low water. Escapement monitoring in August and September was conducted through a cooperative agreement with USFWS. USFWS monitored escapement using the resistance board weir and an underwater video camera (Anderson and Stillwater Sciences 2011).
2011–2012	Chinook salmon escapement was monitored over the entire run at approximately RKM 2.8 through a combination of DIDSON during periods of high water and resistance board weir fitted with an underwater video camera during periods of low water. In 2011, escapement monitoring in August and September was conducted through a cooperative agreement with USFWS.
2013	Chinook salmon escapement was monitored over the entire run; however, high river flows changed the channel morphology at the RKM 2.83 mainstem site used from 2003 to 2012. During the early high flows, DIDSON was used about 0.3 RKM downstream of the mainstem site at Bridge Hole. Once flows subsided, new weir sites were identified upstream on the north fork at RKM 5.5 and the south fork at RKM 4.1.

Appendix A2.—Timeline of sport harvest monitoring and escapement goals for Chinook salmon on the Anchor River, 1950–2013

Year (s)	Sport harvest assessment
1950s	Periodic fisheries investigations in the Anchor River were conducted by U.S. Fish and Wildlife Service. Chinook salmon harvest was monitored through creel surveys.
1966–1977	Punch cards were used to enforce daily and seasonal limits (Hammarstrom et al. 1985).
1971–1977	Punch card returns were the primary source of harvest data. Effort was estimated by car counts each day at campgrounds and parking areas from 1971 to 1976.
1972–1986	Creel surveys were conducted at the Deep Creek access from 1972 to 1986 and 1994 (Nelson 1994, 1995). A creel survey at the Anchor River–Whiskey Gulch access was conducted in 1986 (Nelson 1994).
1976–1983	Age composition of the Chinook salmon harvest was estimated for the Anchor River, Deep Creek, and Ninilchik River (Hammarstrom et al. 1985).
1977 to present	Statewide Harvest Surveys (SWHS) were conducted and produced annual estimates of total catch and harvest for Chinook salmon in the Anchor River.
Year (s)	Escapement goals
1993–1997	The first biological escapement goal (BEG) of 1,790 Chinook salmon was adopted in 1993. The BEG was the average of the expanded estimates from aerial and foot survey index counts conducted from 1966 to 1969 and from 1972 to 1991.
1998–2000	In 1998, the BEG was rescaled to a range of 1,050–2,200 Chinook salmon and was based on historical aerial survey counts and their relationship to sport harvest. The escapement range was approximated with a median aerial survey count of 1,211 Chinook salmon. The upper end of the range was the value that 20% of the annual aerial counts were above. The lower end was the value that 40% of the annual aerial counts were below (Szarzi and Begich 2004: page 22).
2001–2004	In 2001, the sustainable escapement goal (SEG) of 750 to 1500 Chinook salmon was adopted. The SEG was the 25th and 75th percentiles of the annual aerial counts from 1976 through 2000 (Szarzi and Begich 2004: page 22). During the Alaska Board of Fisheries (BOF) meeting in February 1999, in response to the guidelines established in the <i>Sustainable Salmon Fisheries Policy</i> , BOF designated Anchor River Chinook salmon as a stock of “management concern” defined in the policy as “a concern arising from a chronic inability, despite use of specific management measures, to maintain escapements for a salmon stock within the bounds of the SEG, BEG, [optimal escapement goal] OEG, or other specified management objectives for the fishery” (5 AAC 39.222 [f] [21]) (Szarzi and Begich 2004: page 25).
2005–2007	In 2005, the SEG was repealed and no new goal was adopted in anticipation that SF would collect sufficient escapement data with the DIDSON–weir project to recommend an escapement goal (Szarzi et al. 2007).
2008	ADF&G adopted a lower bound SEG of 5,000 Chinook salmon. The SEG was based on a full probability spawner-recruit model that incorporated aerial survey data and SWHS harvest estimates from 1977 to 2007, and the total escapement estimates and age composition data collected from the DIDSON–weir project from 2003 to 2007 (Szarzi et al. 2007)
2010–2013	ADF&G adopted an SEG range of 3,800–10,000 Chinook salmon. The SEG was based on a full probability spawner-recruit model and was updated with escapement and harvest data through 2009. The lower bound of the SEG is the escapement point estimate of maximum sustained yield. The upper bound is the estimated point of carrying capacity (Otis et al. 2010).

Appendix A3.–Timeline of the freshwater fishing regulations and emergency orders (EOs) for Chinook salmon on the Anchor River, 1960–2013

Closed areas for Chinook salmon	
Year	Chinook salmon fishing regulations
1960–2010	Salmon fishing closed upstream of the confluence of the north and south forks.
1996–2013	The area above “forks” was closed to all fishing until August 1 to protect spawning salmon.
Recording requirements	
Year	Chinook salmon fishing regulations
1966–1980	A Chinook salmon punch card was required by all anglers, including those under 16 years of age.
1980–2013	Anglers recorded Chinook salmon harvest on the back of a sport fishing license or harvest card.
Open season for Chinook salmon by regulation	
Year	Chinook salmon fishing regulations
1960	May 7 to December 31.
1961	May 7 to July 1 only.
1962–1963	May 7 to July 8 only.
1964–1965	Closed.
1966	May 28–June 26 and limited to weekends and holidays or until 500 Chinook salmon 20 inches (in) or longer was attained among the Anchor River, Deep Creek, Ninilchik and Kenai Rivers.
1967	May 27–June 11 opened continuously or until 500 Chinook salmon 20 in or longer was attained among the Anchor River, Deep Creek, Ninilchik and Kenai Rivers.
1968	May 25–June 9 opened continuously or until 500 Chinook salmon 20 in or longer was attained among the Anchor River, Deep Creek, Ninilchik and Kenai Rivers. .
1969	May 24–June 8 opened continuously or until 200 Chinook salmon 20 in or longer was attained among the Anchor River, Deep Creek, Ninilchik and Kenai Rivers.
1970	May 30–June 14 opened continuously or until 200 Chinook salmon 20 in or longer was attained among the Anchor River, Deep Creek, Ninilchik and Kenai Rivers.
1971	Beginning on the Memorial Day weekend for 2 consecutive 2-day weekends (Saturday and Sunday). Quota eliminated.
1972	Beginning on the Memorial Day weekend for 2 consecutive 2-day weekends.
1973–1975	Beginning on the Memorial Day weekend for 3 consecutive 2-day weekends.
1976–1977	Beginning on the Memorial Day weekend for 4 consecutive 2-day weekends.
1978–1988	Beginning on the Memorial Day weekend for 4 consecutive 3-day weekends (weekends include Monday).
1989–2001	Beginning on the Memorial Day weekend for 5 consecutive 3-day weekends (weekends include Monday).
2002–2004	Beginning on the Memorial Day weekend for 4 consecutive 3-day weekends (weekends include Monday).
2005–2007	Beginning on the 3-day weekend before the Memorial Day weekend and 4 consecutive 3-day weekends.
2008–2013	Beginning on the 3-day weekend before the Memorial Day weekend and 4 consecutive 3-day weekends. Also the Wednesdays following each weekend opening.

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Bag, possession, and season limits	
Year	Chinook salmon fishing regulations
1960	Bag and possession limit: 3 salmon over 16 inches in length, of which not more than 2 could be Chinook salmon 20 inches or more in length.
1961–1962	Bag and possession limit: 3 salmon over 20 inches in length, of which not more than 1 could be Chinook salmon 20 inches or more in length.
1963	Bag and possession limit: salmon 16 inches or more in length; 6 coho salmon; 3 pink, chum or sockeye salmon; or 1 Chinook salmon.
1964–1965	Closed.
	Bag and possession limit: 1 Chinook salmon 20 inches or more in length.
1966–1978	Bag and possession limit: 10 Chinook salmon less than 20 inches long. Season limit: 2 Chinook salmon 20 inches or more in length.
	Bag and possession limit: 1 Chinook salmon 20 inches or more in length.
1979–1985	Bag and possession limit: 10 Chinook salmon less than 20 inches long. Season limit: 5 Chinook salmon 20 inches or more in length.
	Bag limit: 1 Chinook salmon 16 inches or more in length.
1986–1995	Bag and possession limit: 10 Chinook salmon less than 16 inches long. Season limit: 5 Chinook salmon 16 inches or more in length.
	Bag limit: 1 Chinook salmon 16 inches or more in length.
1996–1998	Bag and possession limit: 10 Chinook salmon less than 16 inches long. Season limit: 2 Chinook salmon 16 inches or more in length from Deep Creek or the Anchor River combined. After harvesting a Chinook salmon 16 inches or more in length from Deep Creek or the Anchor River, an angler may not fish in either drainage for the rest of that day.
	Bag limit: 1 Chinook salmon 16 inches or more in length.
1996–1998	Bag and possession limit: 10 Chinook salmon less than 16 inches long. Season limit: 2 Chinook salmon 16 inches or more in length from Deep Creek or the Anchor River combined. After harvesting a Chinook salmon 16 inches or more in length from Deep Creek or the Anchor River, an angler may not fish in either drainage for the rest of that day.
	Bag limit: 1 Chinook salmon 20 inches or more in length.
1999–2007	Bag and possession limit: 10 Chinook salmon less than 20 inches long. Season limit: 2 Chinook salmon 20 inches or more in length from Deep Creek or the Anchor River combined. After harvesting a Chinook salmon 20 inches or more in length from Deep Creek or the Anchor River an angler may not fish in either drainage for the rest of that day.
	Bag limit: 1 Chinook salmon 20 inches or more in length.
2008–2010	Bag and possession limit: 10 Chinook salmon less than 20 inches length. Season limit: 5 Chinook salmon 20 inches or more in length.
	Bag limit: 1 Chinook salmon 20 inches or more in length.
2011–2013	Bag and possession limit: 10 Chinook salmon less than 20 in length. Season limit: 2 Chinook salmon 20 inches or more in length from Deep Creek or the Anchor River combined. After harvesting a Chinook salmon 20 inches or more in length from Deep Creek or the Anchor River an angler may not fish in either drainage for the rest of that day.

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Emergency orders (EOs)	
Year	Chinook salmon fishing regulations
1971	EO extended the Chinook salmon fishery on Anchor River and Deep Creek an additional 2-day weekend due to low catches (Nelson 1972).
1972	EO extended the Chinook salmon fishery on Anchor River and Deep Creek an additional 2-day weekend due to low catches (Nelson 1972).
1988	EO 2-KS-1-04-88 extended the Chinook salmon fishery on Anchor River and Deep Creek an additional weekend. Highly turbid river conditions early in the season depressed angler success rates and managers' expectations (D. C. Nelson, unpublished ⁶).
2004	EO 2-KS-7-07-04 opened the Anchor River Chinook salmon fishery from 12:00 AM on Saturday, June 26 through 11:59 PM on June 28 from the mouth of the Anchor River to 600 ft downstream of the confluence of the north and south forks. Bag limit: 1 Chinook salmon per day.
2009	EO 2-KS-7-08-09 closed the Anchor River drainage from its mouth upstream to the north and south forks to fishing and increased the closed area in the salt waters of Cook Inlet at the mouth of the Anchor River from 2 miles to 4 miles beginning 12:01 AM on Saturday, June 6 through 11:59 PM on Tuesday, June 30.
2010	EO 2-KS-7-10-10 prohibited the use of bait in the Anchor River, Deep Creek, and Ninilchik River drainages and increased the closed area in the salt waters of Cook Inlet at the mouth of the Anchor River from 1 to 2 miles north and south of the Anchor River mouth and 1 mile offshore beginning 12:01 AM on Saturday, June 5 through 11:59 PM on Wednesday, June 30.
	EO 2-KS-7-15-10 prohibited the retention of Chinook salmon in the Anchor River drainage from its mouth upstream to the junction of the north and south forks beginning 12:01AM on Saturday, June 12 through 11:59 PM on Wednesday, June 30. Chinook salmon may not be possessed or retained; Chinook salmon caught may not be removed from the water and must be released immediately. EO 2-KS-7-10-10 which prohibited the use of bait in the Anchor River, Deep Creek, and Ninilchik River drainages remained in effect.
	EO 2-KS-7-28-10 closed the salt waters of Cook Inlet at the mouth of the Anchor River to all sport fishing from 2 miles north and south of the Anchor River mouth and 1 mile offshore beginning 12:01 AM on Thursday, July 1 through 11:59 PM on Saturday, July 31.
	EO 2-KS-7-36-10 rescinded EO 2-KS-7-28-10 issued June 29. Effective 12:01 AM on Tuesday, July 13, the salt waters of Cook Inlet at the mouth of the Anchor River from 2 miles north and south of the Anchor River mouth and 1 mile offshore were open to all sport fishing.
2011	EO 2-KS-7-06-11 prohibited the use of bait in the Anchor River, Deep Creek, and Ninilchik River drainages beginning June 11 through 11:50 PM, Wednesday, June 22.
	EO 2-KS-7-07-11 closed the waters of the Anchor River drainage from its mouth upstream to the junction of the North and South forks to sport fishing beginning 12:01 AM, Wednesday, June 15 through 11:59 PM, Thursday, June 30.
	EO 2-KS-7-16-11 required the use of only 1 unbaited, single-hook, artificial lure in the flowing waters of the Anchor River drainage, and closed the salt waters of Cook Inlet at the mouth of the Anchor River to all sport fishing from 2 miles north and south of the Anchor River mouth and 1 mile offshore beginning 12:01 AM, Friday, July 1 through 11:59 PM, Sunday, July 31.

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⁶ Nelson, D. C. *Unpublished*. A review of Alaska's Kenai Peninsula east side beach recreational razor clam (*Siliqua patula*, Dixon) fishery, 1965-1980. Alaska Department of Fish and Game, Division of Sport Fish, Soldotna, Alaska.

Emergency orders (EOs)	
Year	Chinook salmon fishing regulations
2012	EO 2-KS-7-08-12 closed waters of the Anchor River drainage from its mouth upstream to the junction of the north and south forks to sport fishing each Wednesday during the Chinook salmon season beginning 12:01 AM, Saturday, May 19. In addition, this EO also decreases the waters of the Anchor River drainage open to sport fishing by relocating the ADF&G regulatory marker downstream approximately 1,000 feet below the junction of the north and south forks beginning 12:01 AM, Saturday, May 19 through 11:59 PM, Tuesday, July 31.
	EO 2-KS-7-09-12 limits sport fishing gear to only 1 unbaited, single-hook, artificial lure when fishing in the Anchor River, Deep Creek, and Ninilchik River drainages beginning 12:01 AM, Saturday, June 2 through 11:59 PM, Wednesday, June 20.
	EO 2-KS-7-10-12 closes waters of the Anchor River drainage from its mouth upstream to the junction of the north and south forks to sport fishing beginning 12:01 AM., Saturday, June 9 through 11:59 PM, Saturday, June 30.
	EO 2-KS-7-13-12 prohibited sport fishing within 1 mile of shore in the salt waters of Cook Inlet south of the latitude of the mouth of the Ninilchik River to the latitude of Bluff Point beginning 12:01 AM, Friday, June 15 through 11:59 PM, Saturday, June 30.
	EO 2-KS-7-21-12 closed waters of the Anchor River and Ninilchik River, from the mouth upstream approximately 2 miles to ADF&G markers, to sport fishing for any species of fish, beginning 12:01 AM, Sunday, July 1 through 11:59 PM, Sunday, July 15.
	EO 2-KS-7-22-12 limited sport fishing gear to only 1 unbaited, single-hook, artificial lure when fishing in the Ninilchik River, Deep Creek, Stariski Creek, and Anchor River drainages beginning 12:01 AM, Sunday, July 1 through 11:59 PM, Tuesday, July 31.
	EO 2-KS-7-23-12 prohibited the retention of Chinook salmon while sport fishing within 1 mile of shore in the salt waters of Cook Inlet south of the latitude of the mouth of the Ninilchik River to the latitude of Bluff Point beginning 12:01 AM, Sunday, July 1 through 11:59 PM, Sunday, July 15. Catch-and-release fishing for Chinook salmon is allowed, but Chinook salmon may not be retained or possessed. Chinook salmon that are caught may not be removed from the water and must be released immediately.
2013	EO 2-KS-7-41-12 prohibited the retention of Chinook salmon while sport fishing within 1 mile of shore in the salt waters of Cook Inlet south of the latitude of the mouth of the Ninilchik River to the latitude of Bluff Point beginning 12:01 AM, Monday, July 16 through 11:59 PM, Tuesday, July 31. Catch-and-release fishing for Chinook salmon is allowed, but Chinook salmon may not be retained or possessed. Chinook salmon that are caught may not be removed from the water and must be released immediately.
	EO 2-KS-7-03-13 closed waters of the Anchor River drainage from its mouth upstream to the junction of the north and south forks to sport fishing each Wednesday during the Chinook salmon season and decreased the waters of the Anchor River drainage open to sport fishing by relocating the ADF&G regulatory marker downstream approximately 1,000 feet below the junction of the north and south forks. This EO was effective from 12:01 AM, Wednesday, May 1 through 11:59 PM, Sunday, June 30.

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Emergency orders (EOs)	
Year	Chinook salmon fishing regulations
2013	EO 2-KS-7-03-13 closed waters of the Anchor River drainage from its mouth upstream to the junction of the north and south forks to sport fishing each Wednesday during the Chinook salmon season and decreased the waters of the Anchor River drainage open to sport fishing by relocating the ADF&G regulatory marker downstream approximately 1,000 feet below the junction of the north and south forks. This EO was effective from 12:01 AM, Wednesday, May 1 through 11:59 PM, Sunday, June 30.
	EO 2-KS-7-04-13 established a combined annual limit of 2 Chinook salmon 20 inches or greater in length for fish harvested in the Anchor River, Deep Creek, Ninilchik River, and all marine waters south of the latitude of the mouth of the Ninilchik River (lat 60°03.99'N) to the latitude of Bluff Point (lat 59°40.00' N). In addition, a person who takes and retains a Chinook salmon 20 inches or greater in length from either Deep Creek, Anchor River, or Ninilchik River may not sport fish in any of those drainages for the rest of that day. This EO was effective from 12:01 AM, Wednesday, May 1 through 11:59 PM, Sunday, June 30. Any Chinook salmon caught in these waters and recorded before Wednesday, May 1 on the harvest portion of an Alaska sport fishing license or harvest record card did not count against the 2 Chinook salmon annual limit after 12:01 AM, Wednesday, May 1, but did count against the Cook Inlet annual limit of 5 Chinook salmon.
	EO 2-KS-7-05-13 limited sport fishing gear to only 1 unbaited, single-hook, artificial lure when fishing in the Anchor River, Deep Creek, or Ninilchik River drainages beginning 12:01 AM, Wednesday, May 1 through 11:59 PM, Sunday, June 30.
	EO 2-KS-7-17-13 superseded EO 2-KS-7-03-13 and EO 2-KS-7-06-13 issued April 18. This EO closed waters of the Anchor River, Deep Creek, Ninilchik River and Stariski Creek, from the mouth upstream approximately 2 miles to ADF&G markers, or to clearly recognizable physical features, to sport fishing for any species of fish, beginning 12:01 AM, Saturday, June 15 through 11:59 PM, Monday, July 15.
	EO 2-KS-7-18-13 superseded EO 2-KS-7-04-13, issued April 18. This EO prohibited Chinook salmon fishing (including catch-and-release) while sport fishing within 1 mile of shore in the salt waters of Cook Inlet south of the latitude of the mouth of the Ninilchik River (lat 60°03.99'N) to the latitude of Bluff Point (lat 59°40.00'N). Chinook salmon incidentally caught while fishing for other fish may not be removed from the water and must be released immediately. This EO was effective from 12:01 AM, Saturday, June 15 through 11:59 PM, Monday, July 15.

**APPENDIX B: DAILY ESCAPEMENT COUNTS AT THE
ANCHOR RIVER SONAR AND WEIR SITES, 2013**

Appendix B1.—Daily and cumulative (cum.) escapement counts of Chinook, pink, chum, sockeye, and coho salmon; Dolly Varden; and steelhead trout at the Anchor River sonar and weir sites, 2013.

Date	Chinook count ^a			Dolly Varden count			Pink count			Chum count			Sockeye count			Coho count			Steelhead count		
	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
15 May	0	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16 May	0	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17 May ^b	0	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18 May ^b	0	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19 May	3	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20 May	0	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21 May	0	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22 May	0	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23 May	0	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24 May	0	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25 May ^b	0	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26 May ^b	0	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27 May	0	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28 May	0	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29 May	0	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30 May ^b	0	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31 May	9	12	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1 Jun ^b	25	37	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2 Jun	39	76	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3 Jun ^b	62	138	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4 Jun	81	219	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5 Jun	33	252	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6 Jun	42	294	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7 Jun	18	312	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8 Jun	57	369	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9 Jun	126	495	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10 Jun ^b	159	654	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11 Jun	246	900	20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12 Jun ^b	108	1,008	23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

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Date	Chinook count ^a			Dolly Varden count			Pink count			Chum count			Sockeye count			Coho count			Steelhead count		
	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
13 Jun	123	1,131	26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14 Jun	147	1,278	29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15 Jun	177	1,455	33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16 Jun	186	1,641	37	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17 Jun	99	1,740	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18 Jun	162	1,902	43	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19 Jun ^c	419	2,321	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Jun	85	2,406	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Jun	15	2,421	55	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	100
22 Jun	34	2,455	56	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100
23 Jun	25	2,480	56	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100
24 Jun	64	2,544	58	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100
25 Jun	114	2,658	60	2	3	0	1	1	0	1	1	4	0	0	0	0	0	0	0	1	100
26 Jun	79	2,737	62	1	4	0	2	3	0	0	1	4	0	0	0	0	0	0	0	1	100
27 Jun	92	2,829	64	2	6	0	0	3	0	0	1	4	0	0	0	0	0	0	0	1	100
28 Jun	68	2,897	66	2	8	1	1	4	0	4	5	19	0	0	0	0	0	0	0	1	100
29 Jun	39	2,936	67	3	11	1	0	4	0	1	6	22	0	0	0	0	0	0	0	1	100
30 Jun	80	3,016	69	8	19	1	8	12	1	3	9	33	1	1	17	0	0	0	0	1	100
1 Jul	89	3,105	71	7	26	2	14	26	3	0	9	33	0	1	17	0	0	0	0	1	100
2 Jul	62	3,167	72	2	28	2	11	37	4	0	9	33	0	1	17	0	0	0	0	1	100
3 Jul ^b	1	3,168	72	0	28	2	0	37	4	0	9	33	0	1	17	0	0	0	0	1	100
4 Jul ^b	28	3,196	73	0	28	2	0	37	4	0	9	33	2	3	50	0	0	0	0	1	100
5 Jul	13	3,209	73	2	30	2	2	39	4	0	9	33	0	3	50	0	0	0	0	1	100
6 Jul	39	3,248	74	8	38	2	21	60	6	3	12	44	0	3	50	0	0	0	0	1	100
7 Jul	453	3,701	84	10	48	3	93	153	16	3	15	56	0	3	50	0	0	0	0	1	100
8 Jul	54	3,755	85	3	51	3	20	173	18	0	15	56	0	3	50	0	0	0	0	1	100
9 Jul	41	3,796	86	9	60	4	26	199	21	2	17	63	0	3	50	0	0	0	0	1	100
10 Jul	45	3,841	87	36	96	6	55	254	27	0	17	63	0	3	50	0	0	0	0	1	100
11 Jul	56	3,897	89	70	153	10	58	312	33	0	17	63	0	3	50	0	0	0	0	1	100
12 Jul ^b	69	3,966	90	46	212	14	118	430	45	1	18	67	0	3	50	0	0	0	0	1	100
13 Jul	24	3,990	91	30	242	16	28	458	48	3	21	78	0	3	50	0	0	0	0	1	100

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Date	Chinook count ^a			Dolly Varden count			Pink count			Chum count			Sockeye count			Coho count			Steelhead count		
	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
14 Jul	23	4,013	91	59	301	20	46	504	53	0	21	78	1	4	67	0	0	0	0	1	100
15 Jul	26	4,039	92	101	379	25	47	551	58	1	22	81	0	4	67	0	0	0	0	1	100
16 Jul	18	4,057	92	171	573	38	71	622	65	0	22	81	0	4	67	0	0	0	0	1	100
17 Jul	62	4,119	94	126	699	46	70	692	73	0	22	81	0	4	67	0	0	0	0	1	100
18 Jul	40	4,159	95	74	773	51	23	715	75	1	23	85	0	4	67	0	0	0	0	1	100
19 Jul	70	4,229	96	35	808	53	30	745	78	0	23	85	0	4	67	0	0	0	0	1	100
20 Jul	53	4,282	97	7	815	54	6	751	79	0	23	85	0	4	67	0	0	0	0	1	100
21 Jul	6	4,288	97	70	862	57	1	752	79	0	23	85	0	4	67	0	0	0	0	1	100
22 Jul	2	4,290	97	81	966	63	2	754	79	0	23	85	0	4	67	0	0	0	0	1	100
23 Jul	7	4,297	98	34	1,000	66	8	762	80	0	23	85	0	4	67	0	0	0	0	1	100
24 Jul	13	4,310	98	45	1,041	68	11	773	81	1	24	89	0	4	67	0	0	0	0	1	100
25 Jul	16	4,326	98	20	1,065	70	19	792	83	0	24	89	0	4	67	0	0	0	0	1	100
26 Jul	25	4,351	99	41	1,106	73	26	818	86	0	24	89	0	4	67	0	0	0	0	1	100
27 Jul	16	4,367	99	134	1,240	81	51	869	91	1	25	93	0	4	67	0	0	0	0	1	100
28 Jul	7	4,374	99	63	1,303	86	20	889	94	0	25	93	0	4	67	0	0	0	0	1	100
29 Jul	12	4,386	100	23	1,326	87	11	900	95	1	26	96	1	5	83	0	0	0	0	1	100
30 Jul	6	4,392	100	16	1,342	88	15	915	96	0	26	96	0	5	83	0	0	0	0	1	100
31 Jul	1	4,393	100	20	1,361	89	6	921	97	0	26	96	1	6	100	0	0	0	0	1	100
1 Aug	2	4,395	100	22	1,384	91	9	930	98	1	27	100	0	6	100	0	0	0	0	1	100
2 Aug	3	4,398	100	128	1,473	97	13	943	99	0	27	100	0	6	100	1	1	100	0	1	100
3 Aug	3	4,401	100	11	1,523	100	7	950	100	0	27	100	0	6	100	0	1	100	0	1	100

Note: En dash denotes no information.

^a Escapement census using DIDSON expanded counts (2,238, SE 117) began at 1900 hours on 15 May and ended at 1200 hours on 19 June and weir counts (2,163) began at 1300 hours on 19 June and ended at 2359 hours on 3 August.

^b Dates when some hours were interpolated due to equipment malfunction. Refer to Appendix B4 for details of interpolated hours.

^c Escapement on 19 June based on 336 fish estimated from 0000 to 1200 hours using DIDSON and 83 Chinook salmon counted from 1300 to 2359 hours using weirs operated on the north and south forks.

Appendix B2.—Daily and cumulative (cum.) escapement counts of Chinook, pink, chum, sockeye, and coho salmon; Dolly Varden; and steelhead trout at the Anchor River south fork weir site, 2013.

Date	Chinook count ^a			Dolly Varden count			Pink count			Chum count			Sockeye count			Coho count			Steelhead count		
	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
19 Jun	82	82	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Jun	85	167	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Jun	15	182	12	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	100
22 Jun	23	205	13	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100
23 Jun	0	205	13	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100
24 Jun	48	253	16	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100
25 Jun	73	326	21	2	3	0	1	1	0	1	1	5	0	0	0	0	0	0	0	1	100
26 Jun	71	397	25	1	4	0	2	3	0	0	1	5	0	0	0	0	0	0	0	1	100
27 Jun	85	482	31	2	6	1	0	3	0	0	1	5	0	0	0	0	0	0	0	1	100
28 Jun	56	538	34	2	8	1	1	4	1	4	5	23	0	0	0	0	0	0	0	1	100
29 Jun	38	576	37	3	11	1	0	4	1	0	5	23	0	0	0	0	0	0	0	1	100
30 Jun	69	645	41	7	18	2	8	12	2	3	8	36	0	0	0	0	0	0	0	1	100
1 Jul	72	717	45	5	23	2	12	24	3	0	8	36	1	1	25	0	0	0	0	1	100
2 Jul	35	752	48	2	25	3	11	35	5	0	8	36	0	1	25	0	0	0	0	1	100
3 Jul ^a	1	753	48	0	25	3	0	35	5	0	8	36	0	1	25	0	0	0	0	1	100
4 Jul ^a	15	768	49	0	25	3	0	35	5	0	8	36	2	3	75	0	0	0	0	1	100
5 Jul	12	780	49	2	27	3	2	37	5	0	8	36	0	3	75	0	0	0	0	1	100
6 Jul	26	806	51	7	34	3	21	58	8	3	11	50	0	3	75	0	0	0	0	1	100
7 Jul	226	1,032	65	9	43	4	84	142	19	3	14	64	0	3	75	0	0	0	0	1	100
8 Jul	51	1,083	69	3	46	5	20	162	21	0	14	64	0	3	75	0	0	0	0	1	100
9 Jul	37	1,120	71	9	55	6	26	188	25	2	16	73	0	3	75	0	0	0	0	1	100
10 Jul	44	1,164	74	32	87	9	55	243	32	0	16	73	0	3	75	0	0	0	0	1	100
11 Jul	47	1,211	77	53	140	14	54	297	39	0	16	73	0	3	75	0	0	0	0	1	100
12 Jul	62	1,273	81	59	199	20	117	414	55	1	17	77	0	3	75	0	0	0	0	1	100
13 Jul	23	1,296	82	27	226	23	22	436	58	3	20	91	0	3	75	0	0	0	0	1	100
14 Jul	18	1,314	83	59	285	29	25	461	61	0	20	91	1	4	100	0	0	0	0	1	100
15 Jul	19	1,333	85	76	361	37	15	476	63	0	20	91	0	4	100	0	0	0	0	1	100
16 Jul	17	1,350	86	34	395	40	67	543	72	0	20	91	0	4	100	0	0	0	0	1	100
17 Jul	62	1,412	90	126	521	53	70	613	81	0	20	91	0	4	100	0	0	0	0	1	100
18 Jul	39	1,451	92	73	594	60	23	636	84	1	21	95	0	4	100	0	0	0	0	1	100

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Date	Chinook count ^a			Dolly Varden count			Pink count			Chum count			Sockeye count			Coho count			Steelhead count		
	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
19 Jul	47	1,498	95	33	627	64	14	650	86	0	21	95	0	4	100	0	0	0	0	1	100
20 Jul	35	1,533	97	1	628	64	2	652	86	0	21	95	0	4	100	0	0	0	0	1	100
21 Jul	6	1,539	98	47	675	68	1	653	86	0	21	95	0	4	100	0	0	0	0	1	100
22 Jul	2	1,541	98	104	779	79	1	654	86	0	21	95	0	4	100	0	0	0	0	1	100
23 Jul	0	1,541	98	7	786	80	3	657	87	0	21	95	0	4	100	0	0	0	0	1	100
24 Jul	1	1,542	98	17	803	81	4	661	87	1	22	100	0	4	100	0	0	0	0	1	100
25 Jul	2	1,544	98	2	805	82	1	662	87	0	22	100	0	4	100	0	0	0	0	1	100
26 Jul	8	1,552	98	25	830	84	8	670	89	0	22	100	0	4	100	0	0	0	0	1	100
27 Jul	8	1,560	99	25	855	87	39	709	94	0	22	100	0	4	100	0	0	0	0	1	100
28 Jul	4	1,564	99	42	897	91	13	722	95	0	22	100	0	4	100	0	0	0	0	1	100
29 Jul	9	1,573	100	12	909	92	4	726	96	0	22	100	0	4	100	0	0	0	0	1	100
30 Jul	2	1,575	100	7	916	93	11	737	97	0	22	100	0	4	100	0	0	0	0	1	100
31 Jul	0	1,575	100	0	916	93	4	741	98	0	22	100	0	4	100	0	0	0	0	1	100
1 Aug	1	1,576	100	12	928	94	3	744	98	0	22	100	0	4	100	0	0	0	0	1	100
2 Aug	0	1,576	100	16	944	96	0	744	98	0	22	100	0	4	100	0	0	0	0	1	100
3 Aug	1	1,577	100	42	986	100	13	757	100	0	22	100	0	4	100	0	0	0	0	1	100

^a Dates when some hours were interpolated due to equipment malfunction. Refer to Appendix B4 for details of interpolated hours.

Appendix B3.—Daily and cumulative (cum.) escapement counts of Chinook, pink, chum, sockeye, and coho salmon; Dolly Varden; and steelhead trout at the Anchor River north fork weir site, 2013.

Date	Chinook count ^a			Dolly Varden count			Pink count			Chum count			Sockeye count			Coho count			Steelhead count		
	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
19 Jun	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Jun	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Jun	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Jun	11	12	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Jun	25	37	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Jun	16	53	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Jun	41	94	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Jun	8	102	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Jun	7	109	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Jun	12	121	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Jun	1	122	21	0	0	0	0	0	0	1	1	20	0	0	0	0	0	0	0	0	0
30 Jun	11	133	23	1	1	0	0	0	0	0	1	20	0	0	0	0	0	0	0	0	0
1 Jul	17	150	26	2	3	1	2	2	1	0	1	20	0	0	0	0	0	0	0	0	0
2 Jul	27	177	30	0	3	1	0	2	1	0	1	20	0	0	0	0	0	0	0	0	0
3 Jul	0	177	30	0	3	1	0	2	1	0	1	20	0	0	0	0	0	0	0	0	0
4 Jul	13	190	32	0	3	1	0	2	1	0	1	20	0	0	0	0	0	0	0	0	0
5 Jul	1	191	33	0	3	1	0	2	1	0	1	20	0	0	0	0	0	0	0	0	0
6 Jul	13	204	35	1	4	1	0	2	1	0	1	20	0	0	0	0	0	0	0	0	0
7 Jul	227	431	74	1	5	1	9	11	6	0	1	20	0	0	0	0	0	0	0	0	0
8 Jul	3	434	74	0	5	1	0	11	6	0	1	20	0	0	0	0	0	0	0	0	0
9 Jul	4	438	75	0	5	1	0	11	6	0	1	20	0	0	0	0	0	0	0	0	0
10 Jul	1	439	75	4	9	2	0	11	6	0	1	20	0	0	0	0	0	0	0	0	0
11 Jul	9	448	76	4	13	2	4	15	8	0	1	20	0	0	0	0	0	0	0	0	0
12 Jul ^a	7	455	78	0	13	2	1	16	8	0	1	20	0	0	0	0	0	0	0	0	0
13 Jul	1	456	78	3	16	3	0	16	8	0	1	20	0	0	0	0	0	0	0	0	0
14 Jul	5	461	79	0	16	3	22	38	20	0	1	20	0	0	0	0	0	0	0	0	0
15 Jul	7	468	80	2	18	3	37	75	39	1	2	40	0	0	0	0	0	0	0	0	0
16 Jul	1	469	80	160	178	33	4	79	41	0	2	40	0	0	0	0	0	0	0	0	0
17 Jul	0	469	80	0	178	33	0	79	41	0	2	40	0	0	0	0	0	0	0	0	0
18 Jul	1	470	80	1	179	33	0	79	41	0	2	40	0	0	0	0	0	0	0	0	0

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Appendix B3.–Page 2 of 2.

Date	Chinook count ^a			Dolly Varden count			Pink count			Chum count			Sockeye count			Coho count			Steelhead count		
	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
19 Jul	23	493	84	2	181	34	16	95	49	0	2	40	0	0	0	0	0	0	0	0	0
20 Jul	18	511	87	6	187	35	4	99	51	0	2	40	0	0	0	0	0	0	0	0	0
21 Jul	0	511	87	0	187	35	0	99	51	0	2	40	0	0	0	0	0	0	0	0	0
22 Jul	0	511	87	0	187	35	0	99	51	0	2	40	0	0	0	0	0	0	0	0	0
23 Jul	7	518	88	27	214	40	4	103	53	0	2	40	0	0	0	0	0	0	0	0	0
24 Jul	12	530	90	24	238	44	9	112	58	0	2	40	0	0	0	0	0	0	0	0	0
25 Jul	14	544	93	22	260	48	16	128	66	0	2	40	0	0	0	0	0	0	0	0	0
26 Jul	17	561	96	16	276	51	16	144	75	0	2	40	0	0	0	0	0	0	0	0	0
27 Jul	8	569	97	109	385	72	10	154	80	1	3	60	0	0	0	0	0	0	0	0	0
28 Jul	3	572	98	21	406	76	13	167	87	0	3	60	0	0	0	0	0	0	0	0	0
29 Jul	3	575	98	11	417	78	2	169	88	1	4	80	1	1	50	0	0	0	0	0	0
30 Jul	4	579	99	9	426	79	6	175	91	0	4	80	0	1	50	0	0	0	0	0	0
31 Jul	1	580	99	19	445	83	5	180	93	0	4	80	1	2	100	0	0	0	0	0	0
1 Aug	1	581	99	11	456	85	4	184	95	1	5	100	0	2	100	0	0	0	0	0	0
2 Aug	3	584	100	73	529	99	2	186	96	0	5	100	0	2	100	1	1	100	0	0	0
3 Aug	2	586	100	8	537	100	7	193	100	0	5	100	0	2	100	0	1	100	0	0	0

^a Dates when some hours were interpolated due to equipment malfunction. Refer to Appendix B4 for details of interpolated hours.

Appendix B4.—Dates and hours escapement counts were interpolated due to equipment malfunction, Anchor River, 2013.

Date	Location	Method	Interpolated hours
17 May	Mainstem	DIDSON	0700–1100
18 May	Mainstem	DIDSON	0400–0600
25 May	Mainstem	DIDSON	0600–2359
26 May	Mainstem	DIDSON	0000–1700
30 May	Mainstem	DIDSON	1500
1 Jun	Mainstem	DIDSON	2100
3 Jun	Mainstem	DIDSON	0800–1400
10 Jun	Mainstem	DIDSON	0900–1400
12 Jun	Mainstem	DIDSON	0700–0800
3 Jul	South fork	Video	2100–2359
4 Jul	South fork	Video	0000–0730
12 Jul	North fork	Video	0000–0500

APPENDIX C: COUNTS BASED ON DIDSON FILES

Appendix C1.—Daily upstream, downstream, net counts, based on DIDSON files, Anchor River, 2013.

Date	Upstream	Downstream	Net count ^a	Expanded count	Minutes counted
15 May	0	3	−5	0	100
16 May	2	15	−13	0	480
17 May ^b	4	15	−11	0	380
18 May ^b	4	22	−18	0	420
19 May	19	18	1	3	480
20 May	14	38	−24	0	480
21 May	10	17	−7	0	480
22 May	4	12	−8	0	480
23 May	4	5	−1	0	480
24 May	4	10	−6	0	480
25 May ^b	0	1	−1	0	120
26 May ^b	0	0	0	0	120
27 May	2	18	−16	0	480
28 May	4	15	−11	0	480
29 May	3	12	−9	0	480
30 May ^b	5	7	−2	0	460
31 May	13	10	3	9	480
1 Jun ^b	18	10	8	25	460
2 Jun	25	12	13	39	480
3 Jun ^b	24	5	19	62	340
4 Jun	37	10	27	81	480
5 Jun	19	8	11	33	480
6 Jun	25	11	14	42	480
7 Jun	21	15	6	18	480
8 Jun	30	11	19	57	480
9 Jun	51	9	42	126	480
10 Jun ^b	61	12	50	159	360
11 Jun	118	36	82	246	480
12 Jun ^b	62	27	35	108	440
13 Jun	80	39	41	123	480
14 Jun	103	54	49	147	480
15 Jun	125	66	59	177	480
16 Jun	109	47	62	186	480
17 Jun	163	130	33	99	480
18 Jun	212	158	54	162	480
19 Jun	210	98	112	336	260
Total	1,585	976	608	2,238	15,460

^a Negative net counts from 15 to 30 May set to zero.

^b Dates when some hours were interpolated due to equipment malfunction. Refer to Appendix B4 for details of interpolated hours.

**APPENDIX D: DAILY RIVER STAGE AND
TEMPERATURE FOR ANCHOR RIVER, 2013**

Appendix D1.–Daily river stage average for the south fork Anchor River, 2013.

Day	Daily river stage average (cm) ^a											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	17.8	3.0	70.1	50.7	–	63.8	34.8	16.9	32.4	29.9	57.6	87.5
2	13.0	–	67.5	49.8	–	59.2	36.5	17.0	33.9	28.8	52.1	85.8
3	6.9	–	64.3	49.8	–	56.3	32.3	17.1	47.5	28.1	48.6	85.7
4	5.8	–	62.6	49.7	–	54.9	32.6	17.0	40.1	27.4	46.8	86.6
5	12.4	–	60.8	49.9	–	57.3	33.2	18.0	34.9	26.5	44.9	81.1
6	9.5	–	59.0	50.9	–	51.1	33.4	19.2	33.0	27.1	41.5	78.3
7	7.4	–	58.4	49.0	–	48.3	45.2	18.3	39.3	27.6	40.1	73.8
8	4.6	–	58.0	44.5	–	46.4	42.4	17.8	42.9	59.4	37.7	66.7
9	9.5	–	59.1	44.5	98.6	44.8	36.1	22.1	37.1	66.7	36.4	59.0
10	8.1	–	58.7	46.2	91.4	43.0	32.0	21.0	42.3	48.9	49.5	56.5
11	7.9	–	56.5	45.6	96.8	41.5	29.2	20.9	45.8	53.6	60.8	52.7
12	12.2	–	56.5	43.7	104.1	39.8	29.2	44.7	43.0	48.9	62.2	44.0
13	14.2	–	55.4	44.1	111.4	38.4	27.4	43.7	37.1	53.8	44.4	41.6
14	14.2	–	50.0	44.0	109.5	37.1	25.7	32.6	34.0	50.9	43.0	46.9
15	2.5	–	51.2	44.3	90.3	35.8	24.8	27.3	31.8	48.6	39.4	31.2
16	8.8	–	52.8	44.8	76.7	34.8	24.1	24.8	29.6	49.5	33.4	42.5
17	8.0	–	49.1	43.2	86.5	33.8	23.4	26.0	28.3	46.9	32.3	23.3
18	6.9	–	48.3	43.7	85.8	33.1	22.9	24.6	27.3	46.5	21.8	40.8
19	12.8	–	46.7	45.1	61.2	33.7	22.2	24.1	26.2	46.2	22.9	78.7
20	15.3	–	46.3	47.6	65.0	36.2	21.5	26.4	25.3	42.5	33.8	99.5
21	15.5	–	46.4	50.8	–	33.6	20.8	28.8	25.2	40.3	55.9	–
22	22.1	–	47.0	51.9	–	32.3	19.9	50.0	26.8	40.2	69.5	–
23	19.1	81.9	47.0	59.9	–	31.6	19.1	46.5	25.4	38.4	76.1	–
24	9.4	80.7	46.0	84.9	102.3	31.7	18.9	36.1	24.1	37.8	77.1	–
25	7.3	78.2	45.2	130.5	111.1	30.8	18.2	29.3	54.8	41.4	74.5	–
26	12.1	75.2	44.5	–	106.9	29.8	19.1	25.5	52.7	37.2	69.3	–
27	8.2	73.5	43.4	–	–	29.3	21.5	23.6	43.1	55.9	63.6	–
28	9.0	71.9	44.3	–	80.7	28.7	20.3	22.6	38.0	104.7	67.3	–
29	9.4		46.6	–	90.4	28.5	19.1	41.7	34.5	101.6	76.1	–
30	15.2		46.0	–	82.0	27.5	18.0	43.2	32.1	69.1	83.7	–
31	14.4		49.1		71.9		17.3	35.5		62.1		–

Note: En dash denotes no information.

Source: Retrieved on 2014-09-25 19:40:37 EDT (nadm01) from

http://waterdata.usgs.gov/ak/nwis/uv/?site_no=15239900&PARAMeter_cd=00065,00060.

^a Stage data were collected at gauge station USGS 15239900, located approximately 11.4 RKM on the south fork, Anchor River.

Appendix D2.–Daily river temperature average (°C), Anchor River, 2013.

Day	Daily temperature average (°C)														
	May			June			July			August			September		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
1	0.0	0.0	0.1	6.4	5.5	7.4	10.7	10.1	11.8	15.6	13.7	18.0	10.8	9.9	11.6
2	0.0	0.0	0.1	5.8	4.2	7.7	10.8	9.2	12.9	15.0	13.7	15.8	10.6	10.1	11.1
3	0.0	0.0	0.1	6.1	5.3	7.0	11.4	10.0	12.5	14.5	13.3	15.8	10.2	9.2	11.3
4	0.0	0.0	0.1	6.5	5.4	8.1	10.6	9.8	11.7	14.1	13.0	15.1	10.4	10.0	11.2
5	0.1	0.0	0.1	5.8	4.3	7.3	9.9	9.1	10.7	13.7	12.5	14.8	9.6	8.7	10.5
6	0.1	0.0	0.2	6.5	4.4	8.8	9.6	9.1	10.1	13.1	12.3	14.1	9.5	8.9	10.3
7	0.1	0.0	0.2	8.5	5.8	11.4	9.4	8.8	9.8	13.0	12.2	13.6	10.0	9.4	10.8
8	0.5	0.0	1.4	10.7	8.0	13.6	9.9	8.4	12.1	12.5	11.5	13.4	10.3	9.4	11.5
9	0.5	0.1	1.0	11.7	9.2	14.5	11.3	8.8	14.2	12.1	10.9	13.2	10.2	9.8	10.6
10	0.8	0.1	2.0	12.0	9.5	14.6	12.8	10.1	15.6	12.7	10.7	15.5	10.2	9.4	11.0
11	1.0	0.4	1.8	12.3	9.6	15.1	13.9	10.8	17.4	12.4	11.9	13.5	10.8	10.1	12.0
12	1.2	0.4	2.3	12.7	9.9	15.7	14.4	11.7	17.2	11.6	11.3	12.0	8.7	8.1	10.1
13	1.4	0.4	2.7	12.2	10.4	14.2	13.7	12.0	15.0	11.0	10.6	11.6	9.3	8.3	10.6
14	2.1	0.6	4.1	13.1	10.4	16.2	13.6	11.0	16.6	11.0	9.2	13.2	10.0	9.1	11.2
15	1.9	0.6	3.3	13.2	10.8	16.2	13.9	11.7	16.4	11.7	10.1	13.5	8.9	7.3	10.4
16	1.9	1.3	2.7	13.7	10.9	16.6	15.2	12.7	18.4	11.2	10.3	12.0	7.9	6.2	9.6
17	2.4	1.1	4.2	14.8	11.8	18.0	15.5	13.6	17.9	11.3	10.7	12.2	8.5	7.4	9.7
18	2.4	1.2	4.0	15.6	12.9	18.4	16.1	13.7	18.9	11.7	10.7	12.9	8.1	6.6	9.5
19	3.1	1.0	5.4	13.5	12.4	15.6	16.4	14.1	19.0	11.7	11.3	12.2	6.8	5.4	8.2
20	3.4	1.7	4.9	12.3	10.7	14.1	16.3	13.6	19.3	11.8	10.7	13.2	5.2	3.6	6.5
21	3.8	2.7	4.9	11.2	10.4	12.2	15.5	12.9	18.4	11.4	11.1	12.0	4.9	4.2	5.6
22	3.5	2.5	4.5	9.5	8.5	10.9	15.7	12.2	19.2	10.6	10.3	11.1	5.4	4.5	6.6
23	3.4	2.1	4.7	9.5	8.7	10.4	15.6	13.3	17.5	11.5	9.9	13.6	4.8	4.0	6.2
24	4.0	2.0	6.5	11.1	9.0	13.7	16.0	12.5	19.8	11.6	9.6	13.6	3.4	2.1	4.4
25	4.1	1.6	6.7	12.0	9.9	14.3	17.0	14.8	19.7	10.9	8.7	13.1	4.7	4.0	5.6
26	3.8	1.9	5.6	12.5	10.3	14.2	15.9	14.8	17.5	11.1	9.0	13.4	6.0	5.5	7.0
27	5.1	3.0	7.7	12.8	11.3	14.5	15.9	13.8	19.0	12.2	10.5	14.4	6.4	5.9	6.7
28	5.6	2.7	8.8	12.8	12.0	13.5	16.3	13.3	19.7	11.3	10.3	12.3	5.9	5.3	6.6
29	6.3	3.8	8.7	13.7	11.2	17.0	16.7	14.1	19.7	10.3	10.1	10.9	5.9	5.4	6.6
30	6.8	4.4	9.0	12.9	11.5	14.5	16.6	14.0	19.5	10.8	9.8	12.1	5.8	5.1	6.7
31	6.3	4.7	8.2				16.2	13.3	19.4	10.9	10.3	11.6			

Source: Temperature data collected by Sue Mauger of Cook Inletkeeper 0.1 RKM downstream of the resistance board weir.